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CONTENTS

PAGE

MICHIGAN'S FOOD MARKETING BILL AND WHERE TO REDUCE IT ..... *By M. E. Cravens* 169

HIGH VISCOSITY AND PROGRESSIVE THICKENING OF HOMOGENIZED MILK ..... *By A. V. Moore and G. M. Trout* 177

THE COST OF MAKING MAPLE SIRUP ..... *By P. W. Robbins* 188

EATON OATS ..... *By E. E. Down and J. W. Thayer, Jr.* 190

PORTABLE PIPE IRRIGATION PRACTICES IN MICHIGAN ..... *By F. W. Peikert* 194

DORMANT TREATMENTS FOR THE CONTROL OF THE CHERRY CASE-BEARER ..... *By O. W. Hammer and Franklin Sherman III* 205

SHELL TREATING AND MAINTENANCE OF EGG QUALITY IN STORAGE ..... *By J. A. Davidson* 208

ECONOMIC VALUE OF OIL-WAX EMULSION SPRAYS IN CHERRY ORCHARD PRACTICES ..... *By A. L. Neal, V. R. Gardner, E. J. Rasmussen, and E. J. Miller* 220

(Continued on Next Page)

V. R. GARDNER, *Director* - - - - - - - - J. G. DUNCAN, *Editor*

THE QUARTERLY BULLETIN

The Quarterly Bulletin of the Michigan Agricultural Experiment Station is issued in February, May, August and November. It presents: (1) progress reports on long-term major research projects; (2) final reports on short-term projects and (3) short, timely articles of a popular nature that bring together information from various sources on subjects in which farmers are interested.

CONTENTS

(Continued from Outside Front Cover)

PAGE

Spring Wheat Tests at East Lansing, Michigan, 1930-46 ..... *By Hubert M. Brown* 226

Air Dogs for Small Sawmills ..... *By R. C. Johnson* 231

Egg Production and Meat Type Compatability ..... *By Earl W. Henderson* 237

Influence of Separator Cleanliness and Temperature of Cream Storage on Cream Quality ..... *By J. M. Jensen and A. L. Bortree* 243

Modification of the Physiological Action of the Sodium Salt of 2, 4-Dichlorophenoxyacetic Acid by Simultaneous Application of Plant Extracts and by pH Changes ..... *By E. H. Lucas and C. L. Hamner* 256

Bulletin Reviews 263

Journal Article Abstracts 266

MICHIGAN'S FOOD MARKETING BILL AND WHERE TO REDUCE IT[1]

By M. E. CRAVENS

SECTION OF ECONOMICS

THE COST OF marketing Michigan-produced food was about $249,000,000 annually during the 1935-39 prewar years (Table 1). All charges made against the food products, including processing charges, from the time the farmer sold them until they were purchased by the consumer were included as costs. The consumer paid about

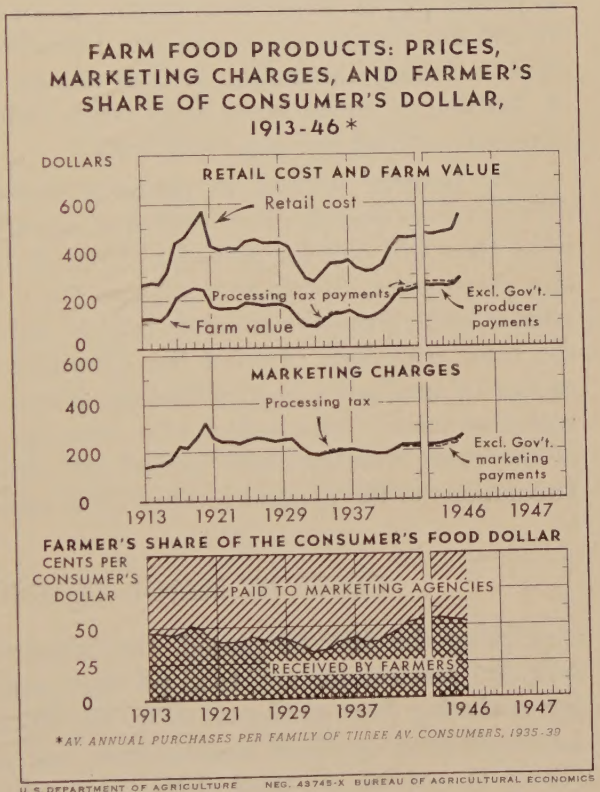

Fig. 1. During 1946 the retail prices of food rose to near record levels and farmers received the greatest percentage of this retail price of any year except 1945.

Since marketing charges stay relatively constant, any decrease in the retail price for food will result in a much smaller percentage of the consumer's dollar for farmers and a corresponding decrease in farm prices.

[1]The author acknowledges the sugggestions of members of the Agricultural Economics Section and particularly those of Dr. C. M. Hardin. Parts of this article were published in the December 1946 issue of *Michigan Farm Economics*.

ARTICLE 29-18

$442,000,000 for this food, and of this the farmer received about $193,000,000. In 29 of the past 34 years, the cost of distributing food has been greater than the amount received by the farmer for producing it. The other five years were during the two wars (Fig. 1).

Reduction of distribution costs is to the interests of farmers, distributors and consumers. Every person employed in the distribution of food means one less man for the production of consumer goods or services. Each dollar paid him increases the price of food and reduces the amount the consumer will buy. It also reduces the returns to farmers. The individual distributor is interested in reducing distribution costs for much the same reason the individual farmer is interested in reducing his production costs. It is to his advantage to keep his costs below those of his competitors so that his profits will be larger than theirs. Since all of us, including farmers and distributors, are consumers, probably the greatest total interest in reducing distribution costs is among consumers. Lower costs of distribution mean lower food costs with the possibility of more purchases of food and non-food items.

The farmers' interest in reducing marketing costs is somewhat different from that of distributors and consumers. Consumers decide what they will pay for a food product or how much they will buy at a given price, distributors subtract their charges, and farmers get what is left. Since the amounts paid to distributors tend to be about the same regardless of what the consumer pays, this system works to the farmers' advantage with high prices and to his disadvantage with low prices. This suggests the necessity for more intensive study of the price structure with special attention to the reasons for the fluctuations in the general level of U. S. and world food prices.

COSTS BY MAJOR COMMODITIES

During the 1935-39 period, the largest payments for food distribution services for any food product produced in Michigan were for marketing dairy products. (Fig. 2.) These products were divided into milk sold for fluid consumption and all other dairy products (Table 1). About one-third of the returns for milk sold by Michigan producers was for milk used for fluid consumption. Less than one-fourth of the total production during this period went into fluid use. Distribution costs of $16,879,000 for this milk were about four-fifths as great as the farm sales value of $20,629,000. For milk going into

TABLE 1—*Farm sales value, estimated marketing costs, and retail values of Michigan-produced food crops, 1935-39 average.**

Product	Farm sales		Cost of marketing	Retail value
	Total value	Percent of retail value		
	(000)	(percent)	(000)	(000)
Dairy products				
Bottled milk	$ 20,629	55	$ 16,879	$ 37,508
Other	42,810	48	46,560	89,370
Vegetables, including potatoes				
Fresh	7,726	32	16,465	24,191
Processed	2,532	15	14,739	17,271
Potatoes	10,513	50	10,513	21,026
Meat animals				
Beef and veal	22,968	55	18,872	41,840
Pork	15,658	52	14,373	30,031
Sheep and lambs	4,828	48	5,230	10,058
Fruits				
Fresh	9,041	39	14,389	23,430
Processed	2,731	14	16,776	19,507
Grain products				
Wheat	7,540	21	28,365	35,905
Other	881	22	3,074	3,955
Poultry and eggs				
Poultry	10,042	56	7,890	17,932
Eggs	17,230	77	5,147	22,377
Field beans	10,617	46	12,463	23,080
Sugar beets	5,036	30	11,750	16,786
Mint	1,092	18	4,975	6,067
Honey and maple products	1,411	75	480	1,891
Total	$193,285	44	$248,940	$442,225

*Annual Crop and Livestock Summary issued by the U. S. Department of Agriculture and Michigan Department of Agriculture.
Miscellaneous Publication 576, "Price Spreads Between Farmers and Consumers for Food Products", U.S.D.A., Bureau of Agricultural Economics.

other uses, the farm value was 10 percent less than the distribution cost.

Vegetables, including potatoes, had the second largest marketing bill. Processed vegetables paid $14,739,000 marketing costs, compared with $16,465,000 for fresh vegetables. The farm value of vegetables sold for processing was less than half as great as for fresh use. Potatoes, with a farm value greater than all other commercially produced vegetables combined, cost about one-third as much to distribute as all other commercial vegetables (Table 1).

Beef, veal and pork producers received slightly more for their livestock than distributors received for getting it from the producer

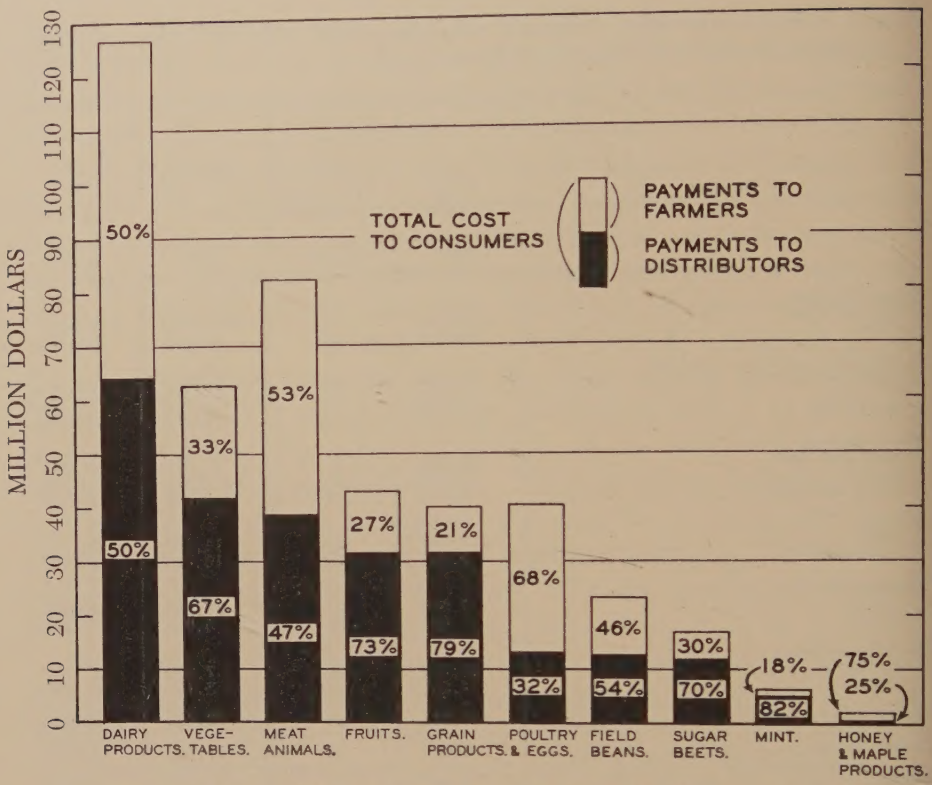

Fig. 2. Retail value of Michigan-produced food with share going to farmers and distributors, 1935-39 annual average. The payments to food distributors varied from about 32 cents of the consumer's dollar for poultry and eggs to about 79 cents in the case of grain products. A major part of the variation was due to the variations in the amount of processing, perishability, and value per pound of the product. The distributor's share included all charges against the product from the time it was sold by the farmer until it was purchased by the consumer.

to consumer. Producers of sheep and lambs received slightly less for producing than distributors for marketing their product.

The relative size of the distribution costs and farmer returns for fruits were much the same as for vegetables. For every dollar the farmer received for producing fruit, the distributors charged about $1.60 for getting it to the consumer fresh and about $6.00 if processed. Fresh fruit was over three times as important a source of farm income as processed fruit.

Most grains were fed on the farm where they were produced. Wheat was the principal grain sold by Michigan farmers and the

principal one used for food. The cost of getting wheat from the farmer to the consumer was four times as great as the return to the farmer for producing it.

Poultry and eggs returned more to the farmer than to the distributor. For each dollar the farmer received, the distributor received about 78 cents for his services in marketing poultry and about 33 cents for eggs.

For field beans, the job of distribution and that of production were apparently about equal, while for sugar the distribution cost twice as much as the amount received by those who produced the sugar beets (Table 1).

The differences in the relative size of farmer returns and distribution costs for the various food products were not caused by variations in efficiency of distributors handling the various groups of commodities. They were due to the nature and amount of processing required, the perishability of the product, the value per pound of product, and other variations in the jobs of producing and distributing food. The size of the jobs was indicated by the amounts of money involved. Producers of meats, poultry, eggs and fluid milk receive a greater share of the consumers' dollar than the distributors of these products. On the other hand, producers of fruits and vegetables, grains, field beans and sugar beets receive considerably less for their product than do those who process and move it from the producer to the consumer.

WHERE TO REDUCE COSTS

In many cases, efficiency in distributing food has not kept pace with that in producing it. This has been due in part to less adequate scientific study of distribution processes than of productive processes. It is necessary that distribution problems receive more scientific study if agriculture is to distribute its products efficiently. It is realized that there are handicaps to the use of marketing research that are less apparent in production studies. From the individual farmer's viewpoint, the application of a new and more efficient marketing process is different from one in production. Improved productive practices which may be suggested by research findings will benefit the individual only if he adopts the practice. The alert farmer can determine whether

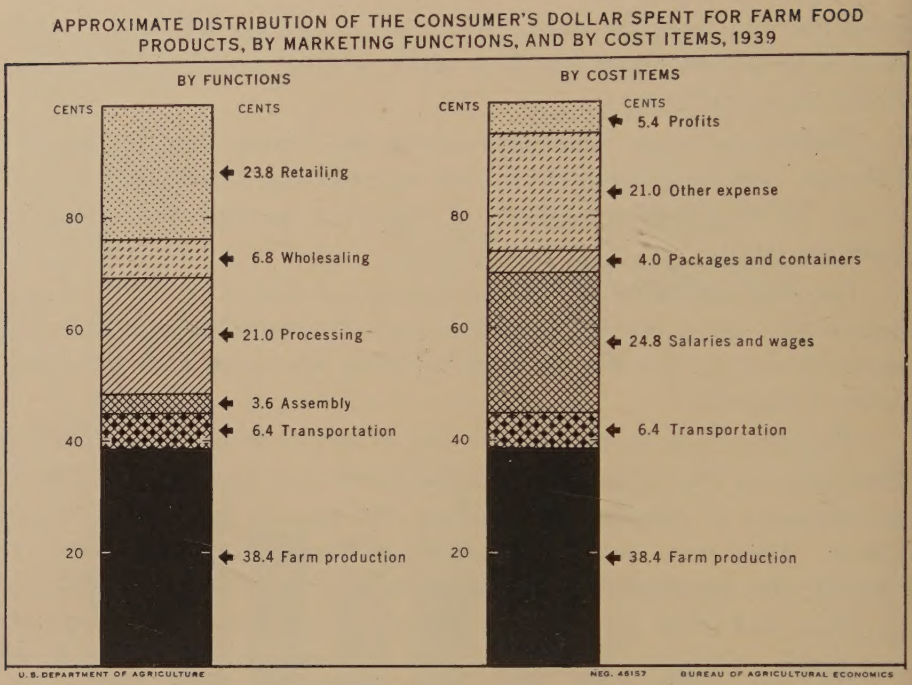

Fig. 3. When the consumer spent a dollar for food in 1939, the farmer got considerably less than half of it. The remainder was absorbed by the expenses of operation and profits of various distribution agencies, including processors. Retailing was the most costly marketing function and labor the largest single item of cost.

the new method is profitable and act to his own best interests. In the case of an improvement in marketing efficiency, however, all farmers who sell the particular product may be benefitted, although they may not realize it.

Recently published data from the Bureau of Agricultural Economics for the United States showed that the farmer received 38.4 cents of the consumer's food dollar in 1939 (Fig. 3). (The 1935-39 average was 40 cents to the farmer and 60 cents to the distributor.) The other 61.6 cents in 1939 was divided among the distribution agencies as follows:

Retailers	23.8 cents	38.7 percent
Processors	21.0 cents	34.1 percent
Wholesalers	6.8 cents	11.0 percent
Transportation Agencies	6.4 cents	10.4 percent
Country Dealers	3.6 cents	5.8 percent
All Distributors	61.6 cents	100.0 percent

From the foregoing figures, it seems that chances for savings might be greater in retailing and processing than elsewhere in the distribution process. Certainly these two accounted for the major part of the marketing charges and together they received more for handling the product than the farmer for producing it. Stated another way, an improvement effecting savings of one percent of the retail charges would net almost one million dollars annually while a similar saving on wholesale charges would net at best about one-quarter million dollars. Needless to say, either of these savings would mean a substantial benefit to both farmers and consumers.

The payment of 61.6 cents to various distributors was spent by them as follows (Fig. 3):

Salaries and wages	24.8 cents	40.3 percent
Transportation	6.4 cents	10.4 percent
Profits	5.4 cents	8.7 percent
Containers	4.0 cents	6.5 percent
Other expense*	21.0 cents	34.1 percent
All Distributors	61.6 cents	100.0 percent

*Includes storage taxes, rent, depreciation, insurance, advertising, and other.

If the labor involved in making the containers, providing transportation, and that listed as other expense were included, labor costs would appear even larger. This emphasizes the desirability of studying means of improving the efficiency of labor used in marketing. One possibility for doing this is through the application of motion and time studies similar to those used in industry, and more recently in agricultural production, to marketing operations. This type of study should be particularly well adapted to the processing and packaging operations for food products.

Increases in wage rates for labor in distribution processes without corresponding increases in efficiency will necessarily increase distribution costs. These increased costs will be borne jointly by all consumers as larger food bills and by farmers as smaller net returns. Laborers—the largest group of consumers—and farmers would be injured most by this policy.

CONCLUSIONS

There is more chance of saving a thousand dollars by the study of a million-dollar operation than by the study of a ten-thousand-dollar operation. It follows that for Michigan farmers as a whole, the

greatest chance of benefit will come through the study of the more costly operations, or in many cases marketing instead of production. By the same measure, it may be of more importance to Michigan farmers to study a major farm enterprise than a minor one.

Of the distribution functions, the study of the retailing and processing operations offers more chance for savings than that of the country assembling or wholesaling of food products. Among the items of cost, the study of labor efficiency offers a greater chance for savings than the study of container costs or profits. A 20-percent reduction in the cost of labor in distribution would reduce the marketing cost more than the complete elimination of profits to middlemen.

No set formula can be devised to list each individual study in the order of its importance. New developments do not affect all food products alike. For example, quick freezing has had and will have a more beneficial effect on the marketing of perishable food products than on non-perishable ones. As these new processes appear, the possibilities of reducing marketing costs of each product should be re-examined. By such an examination, in meat marketing it seems possible that a reduction in the total marketing cost can be attained by the shifting of certain operations from the retail meat cutter to the wholesaler or packer. The basic ideas of freezing and pre-packaging which suggested the meat study were developed for other uses. The idea of mechanical refrigeration was the product of still more basic research. Scientists must continue to develop new ideas and others to apply them to everyday marketing problems if distribution costs are to be reduced.

HIGH VISCOSITY AND PROGRESSIVE THICKENING OF HOMOGENIZED MILK

By A. V. MOORE and G. M. TROUT
SECTION OF DAIRY

WHILE HOMOGENIZED MILK, especially that having a high percentage of fat, often seems richer than that nonhomogenized, it never, under normal processing, becomes so thick or viscous as to attract the attention of the consumer. However, a considerable quantity of high-test (4.5 percent) homogenized milk was returned recently to the plant processing the milk with complaints that the milk was thick and viscous, and that it could not be used. Children refused to drink it. Examination showed the milk to have about the same consistency as thin malted milk and it poured similarly to thin cream. When taken into the mouth it had a feel similar to that of cultured buttermilk. The flavor was good, sweet, but had a slightly chalky aftertaste, showing no evidence of bacterial flavor development despite the fact that it had a physical quality and feel like some well mixed cultured milks, such as cremoris. The milk seemed so creamy that it was conjectured that possibly creamed milk had been homogenized. However, no possible creaming could have occurred as the milk was agitated continuously in the vat. A fat test dispelled the idea that the milk in question may have contained a higher-than-normal percentage of fat.

Investigation into the possible causes of the defect revealed that the only irregularity in processing was the temperature at which the milk was homogenized. The milk was vitamin-D homogenized and, owing to the fact that less than 100 gallons were being processed, the homogenization was done necessarily after pasteurization. The milk was pasteurized at 143° F. and held at that temperature for 30 minutes. Usually homogenization was done immediately following pasteurization but in this instance a delay occurred. Meanwhile, the milk was being cooled in the vat. By the time the homogenizer was ready for use the temperature of the milk had been reduced from 143° F. to 80 F. at which the milk was homogenized at 2500 pounds pressure. Because of the every-other-day delivery system, some of this milk

ARTICLE 29-19

was held longer than usual. During this period the homogenized milk became creamy, as previously described, bringing forth the complaints which were justified. Repetition of the foregoing procedure in the milk plant always resulted in a noticeably thickened milk upon storage.

References to this specific defect of homogenized milk were not noted in the literature, although several references were found concerning the viscosity of homogenized milk. The earliest reference found relative to the effect of homogenization on the viscosity of milk was that of Buglia (1908), who reported an increase in viscosity as a result of the process. The earliest extensive research on homogenization of milk and cream in America seems to be that of Bishop and Murphy (1911). They observed the effect of homogenization on the viscosity of milk and cream, noting that the flow of homogenized cream on a 40° angle plate glass was 4.1 inches per minute as compared with 10.3 inches in the same cream not homogenized. Concerning the influence of homogenization on the viscosity of milk they stated: "Samples of milk and skimmilk were also tested in the same manner. The decrease in the rate of flow due to homogenization was only twenty percent in the case of the milk. With the skimmilk there was no difference which indicated that the fat must be the principal factor in increasing the viscosity after homogenization." They observed greater viscosities in cream homogenized at 140° F. than at 70° F. When the cream which had been homogenized at 70° F. was pasteurized afterward at 140° F. the increased viscosity was lost in a large measure.

Wiegner (1914) noted the increased viscosity of homogenized milk and explained it on the basis of increased adsorption of casein due to the increased surface area of the fat globules. He postulated that in normal and homogenized milks, 2 percent and 25 percent of the total casein, respectively were adsorbed to the fat. Quagliariello (1917) stated that homogenization increased the viscosity. Evensen and Ferris (1924) reported an increase in the viscosity of pasteurized milk as a result of homogenization; viscosity increased with homogenization pressure.

Bateman and Sharp (1928) studied the effect of homogenization on the viscosity of whole milk. The milk was heated to 50° C. (122° F.) and homogenized at 4,000 pounds pressure. Homogenization caused a distinct rise in the viscosity of whole milk, but caused practically no change in the viscosity of skimmilk. The viscosity

values obtained with homogenized whole milk were as constant as those with normal skimmilk, but normal whole milk repeatedly run through a capillary, or agitated, decreased in viscosity. This was attributed to the breaking up of clumps in the latter. Mechanical agitation produced no decrease in the viscosity of skimmilk or of homogenized milk. They noted that when homogenized milk was aged at low temperatures for several days the viscosity increased. They attributed this to an altering of the proteins. The viscosity values obtained with homogenized whole milk were very consistent and reproducible but much difficulty was encountered with normal whole milk at low temperatures because of clumping and creaming.

Doan and Minster (1933) found that the viscosity of milk was increased by homogenization, the increase being greater with increasing percentages of fat in the milk. When the fat content exceeded 6 percent the viscosity increase was very marked. This was believed to be due to fat-globule clustering. In this connection they concluded:

> "The fat clumping obtained in homogenizing milk that contains higher amounts of fat than normal is influenced markedly by the temperature of preheating and its relation to the temperature of homogenization. The greatest degree of clumping occurs with a preheating treatment of 145° F. and a processing temperature of 100° F. or lower. In general, the greater the drop in temperature between preheating and homogenizing, the greater the clumping tendency."

In an earlier work Doan (1929), processing milk at 100° F., found no clumping in a 4.2-percent milk homogenized at 3,500 pounds and held at 10° C. (50° F.) for 48 hours but did observe a clumping tendency in milk containing 7.2 percent fat and pronounced clumping in a sample containing 16.1 percent fat. Working with 20-percent cream, he (1931) observed that lowering the temperature prior to homogenizing increased the fat clumping. Data obtained by homogenizing cream at 80° F. following pasteurization at 145° F., or higher, indicated very pronounced clumping of the fat. Later he (1938) summarized that the viscosity of homogenized milk was higher than that of nonhomogenized milk, but the effect was not great unless the fat content was increased to 5 or 6 percent.

Trout, Halloran, and Gould (1935) observed a decrease in viscosity of pasteurized milk when processed and examined immediately after pasteurization. Trout and Scheid (1941) studied the influence of homogenizing milk at various temperatures **before** pasteurization on

several properties of the milk. Apparently, considering that all homogenization after pasteurization would be done at or near the pasteurizing temperature, they made no studies on the effects of homogenizing at the same temperatures **after** pasteurization. Hence, the defect reported herein was not encountered.

Whitaker and Hilker (1937), preheating milk to 145 F., cooling to various temperatures, homogenizing at 3,000 pounds pressure and then pasteurizing by the holder process, noted fat clumping down to a processing temperature of 100 F. but not at lower temperatures, except in the case of 20-percent cream when clumping was observed at 60° F. No observations were made on increased body of the milk. It should be pointed out, however, that the milk was pasteurized following processing and was held only 18 hours. Thus the conditions were not similar to those alleged to be responsible for the increased viscosity defect encountered here.

Tretsven (1939) concluded that the viscosity of homogenized milk was affected by the fat percentage of the milk and the temperature of homogenization. Farrall (1942) advised that high-temperature homogenization reduced clustering, gave a better break-up and reduced viscosity. Conversely, low-temperature homogenization (120° to 130° F.) reduced break-up and gave more viscosity.

Sommer (1946) explained that the increase in viscosity that would result when milk was homogenized depended not only upon the original and final fat globule sizes, but also upon the degree of clustering and clumping before and after homogenization. The viscosity of the milk sample would be higher if the fat globules were clustered.

Inasmuch as no references were found in the literature dealing specifically with the defect mentioned above, it seemed expedient to make a study of the possible causes of the abnormally viscous homogenized milk.

EXPERIMENTAL

Studies were made on the vitamin-D milk which was being processed routinely in the milk plant of the Michigan State College Creamery. The milk, testing approximately 4.7 percent fat was pasteurized at 143° F. for 30 minutes. Following the holding period, 18 gallons of the mixed milk was drawn off and divided into six lots of 3 gallons each. These lots were tempered at 140°, 120°, 100°, 80°, 60° and 40° F. as rapidly as possible in tap-water and in ice-water

baths. As soon as the milk reached the desired temperature it was homogenized at 2,500 pounds pressure in a 200-gallon-per-hour Cherry-Burrell Viscolizer. Obviously, the time between pasteurization and homogenization for each lot was not constant, owing to the length of time required to cool to the prescribed temperatures. Following homogenization, the samples were all cooled to 40° F., then bottled and stored for various periods of time as the experiment dictated. Five series of trials were run. The comparative viscosities were determined by the out-flow time from a 100 ml. pipette as well as by organoleptic examination. Other observations such as cream plug, cream line, fat clumping, fat rising and flavor were made. The data are presented in tables 1, 2, 3, and 4.

Influence on Viscosity of Various Homogenization Temperatures Following Pasteurization

From the data presented in Table 1 and shown graphically in Fig. 1, it is apparent that the temperature of homogenization following pasteurization has a marked effect on the viscosity of the high testing milk when held 24 hours or longer. Little difference in viscosity was noted when homogenizing the milk at 140°, 120° or 100° F. No abnormal viscosity was noted although the milk was held at 40° F. for 7 days. However, homogenizing the milk at 80° F. following pasteurization resulted in a marked increase in viscosity. At this temperature of processing the viscosity also increased during storage at a greater rate than that homogenized at the higher temperatures. Homogenizing at temperatures below 80° F., that is, at 60° F. and at 40° F., resulted in inadequate dispersion of the fat and a relatively low viscosity. Cream plugs and cream layers invariably

TABLE 1—*The influence of homogenization temperature after pasteurization on the viscosity of the milk. (Average five trials.)*

Temperature of homogenization (° F.)	Outflow time, in seconds, of 100-ml. pipetteful of milk after (40°F.)			
	1 day	2 days	4 days	7 days
140	43.1	44.0	44.2	44.8
120	43.7	45.0	45.3	45.5
100	45.1	46.3	46.8	47.0
80	51.5	54.2	57.7	56.0
60*	42.7	43.2	42.8	42.7
40*	38.6	39.0	38.6	38.7

*At these temperatures the milk was never homogeneous but had a cream plug and cream line showing inadequate homogenization.

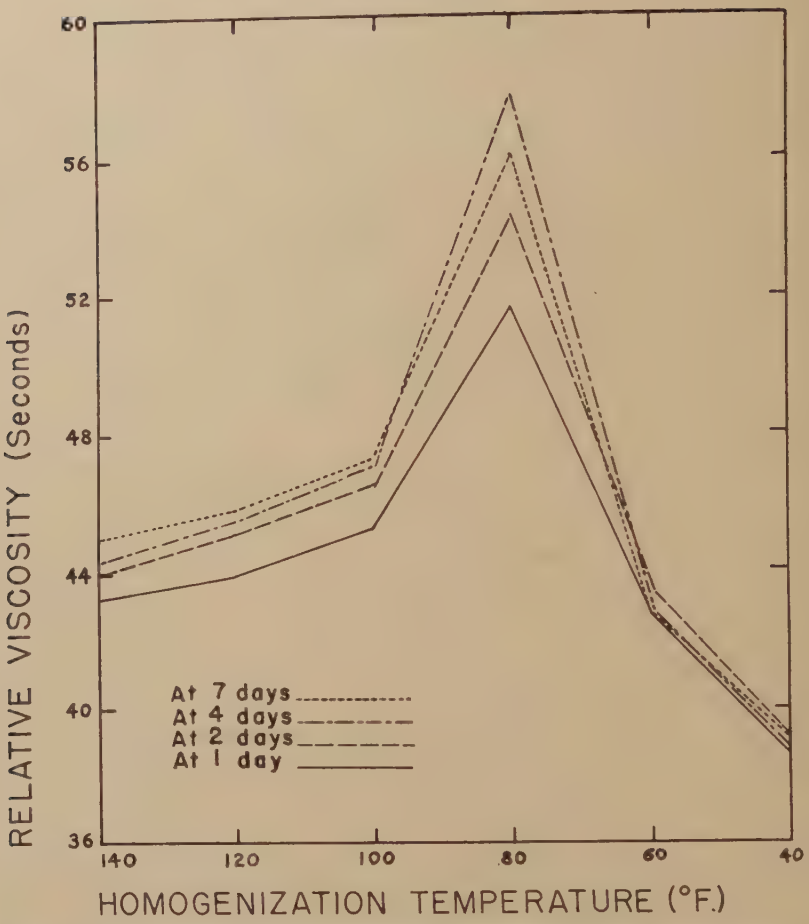

Fig. 1. The influence of homogenization temperature after pasteurization upon the viscosity of the milk.

formed. In some instances the cream plug was distinctly buttery and the under layer was pronouncedly thin in body. When this condition existed the viscosity was not only lower than that in milk homogenized at 100° F. or above, but failed to develop viscosity during storage at 40° F.

Influence Upon Fat Rising of the Temperature of Homogenization After Pasteurization

The data secured on a study of the effect of the temperature of homogenization on fat rising are presented in Table 2. In general, with some exceptions, acceptable homogenization was accomplished

TABLE 2—*Fat rising on milk homogenized at different temperatures following pasteurization.*

Temperature of homogenization (° F).	The percentage difference in fat between that in the upper 100 ml. portion and the remainder of the milk					
	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Average
140	5.9	6.2	4.0	7.7	4.3	5.6
120	7.0	15.0	11.2	1.5	9.8	8.9
100	4.1	11.6	8.0	10.4	4.5	7.7
80	3.5	16.1	13.3	12.5	13.4	11.8
60	168.9	186.4	179.3	140.9	137.3	162.6
40	628.9	418.5	3297.0	619.5	2514.0	1495.5

at temperatures of 100° to 140° F. so far as fat rising was concerned. However, at 80 F. a greater percentage difference was found between the fat in the upper 100 ml. and that in the remaining portion. Nevertheless, evidences of cream plugs and/or cream layers were not noted. On the other hand, the tendency for fat rising was manifest at 80 F. homogenization; was marked at 60° F.; and approached that of normal nonhomogenized milk when homogenization was done at 40 F. following pasteurization. This marked fat rising at the lower temperatures of processing would account in large part for the low viscosity experienced at those temperatures.

Influence of the Temperature of Homogenization After Pasteurization Upon Cream-plug and Cream-line Formation, Fat Clumping and Flavor

Data relative to cream plug, cream line, fat clumping and flavor as influenced by the various temperatures of homogenization after pasteurization are presented in Table 3. As mentioned previously, cream-plug and cream-line formation were noted at the lower proc-

TABLE 3—*Some characteristics of milk homogenized at different temperatures following homogenization when held at 40° F. for 48 hours.*

Temperature of homogenization (° F.)	Cream plug	Cream line	Fat clumping	Flavor	
				Not exposed to sun	Exposed to sun for 30 minutes
140	None	None	No evidence	Excellent	Activated
120	None	None	No evidence	Excellent	Activated
100	None	None	No evidence	Excellent	Activated
80	None	None	Very slight	Chalky	Activated
60	Very slight	None	Large masses	Chalky	Slight activated
40	Heavy, ¼ inch	Three inches	Large masses	Flat, metallic	Oxidized

essing temperatures. Fat clumping and large masses of fat were noted at these temperatures. Slight fat clumping was noted when the milk was homogenized at 80° F. and stored at 40° F. for 48 hours. However, no clumping was observed in the milk homogenized at 100°, 120° or 140° F. and similarly stored.

The flavor of the milk processed at 140°, 120° and 100° F. and stored at 40° F. for 48 hours was excellent, but that processed at 80° F. or below and similarly stored was distinctly chalky or flat. The chalky flavor persisted for some time after the sample had been rejected from the mouth. The data in Table 3 are representative of one trial. Interestingly, when the series was exposed to direct sunlight for 30 minutes the various lots of milk did not respond similarly to the activating rays; that homogenized at 40° F. had a distinctly metallic, oxidized flavor while that homogenized at 80° F. or higher had the more typical activated or sunshine flavor. Inasmuch as little or no homogenization was accomplished at 40° F., these observations are in keeping with previous researches showing the protective influence of homogenization against oxidized flavor development and the greater susceptibility of homogenized milk to the activated or sunshine flavor.

DISCUSSION

Obviously, this defect noted in homogenized milk is of interest only to a small percentage of distributors handling homogenized milk, especially those processing a small quantity of high-test milk, and to research workers. It is inconceivable that pasteurized milk will be cooled in a vat to 80° F., the temperature zone at which the defect is most pronounced, regularly before homogenization. On the other hand, a sufficient delay in homogenization after pasteurization might occur so that the relatively small amount of milk in the vat would be cooled quickly to the hazardous temperature zone. In every-day delivery the milk would likely not be kept so long in the home, and the defect, while noticeable, would not be so pronounced as possibly under the system of every-other-day delivery. Since every-other-day delivery is the prevailing system, there seems to be merit in calling the attention of those homogenizing milk to the possibility of the occurrence of this defect so that sound explanations and corrective measures would be available.

The studies reported herein on the progressive thickening of homogenized milk are by no means complete. The data obtained

on the five trials do furnish some interesting observations in connection with the defect. The data substantiate the alleged cause of the defect and the observation in the plant that the defect occurs when the milk is cooled to and homogenized at 80° F. following pasteurization. The defect is aggravated markedly by longer-than-usual home storage. Apparently the marked increase in viscosity is associated both with fat clumping and adsorption of caseous material on the increased surface layer of the fat globules as suggested by several workers. Maximum viscosity was encountered at 80° F., a temperature below that of the melting point of milk fat and at which solidification of fat, if not actually occurring, had that tendency. Thus, it is not inconceivable that the violent treatment of homogenization, while dispersing the liquid fat globules, caused the dispersed fat to crystallize at a more-rapid-than-normal rate. During this rapid crystallization the agglutinin present in the serum may have tended to be more strongly adsorbed by the solidifying fat globules as noted by Sharp and Krukovsky (1939). That rapid crystallization and maximum adsorption were occurring at this temperature is further shown by the behavior of the homogenized milk which was homogenized at 60° and at 40° F. Either cream plugs or cream lines, or both formed at these temperatures, thus showing inadequate homogenization due to the physical condition of the fat. Also, the different flavor development furnishes further evidence that fat surfaces are not the same at all temperatures of homogenization. Considering the vigorous treatment of the homogenization process when a portion of the fat at least, was in a liquid or plastic state, it would seem that sufficient dispersion to inhibit creaming or churning could be attained unless some phenomena associated with adsorption and rapid crystallization were taking place. In earlier work (14) it was shown that when milk previously held at 40° F. for 24 hours was homogenized at 40°, 60°, or 80° F. the globules were not dispersed, which result was expected, but cream plugs such as were encountered in this study were not observed.

The fact that the milk homogenized at 80° F. after homogenization tasted chalky would possibly indicate further that much fat-surface adsorption had taken place in this temperature zone, enhanced perhaps by rapid crystallization induced by the rigorous treatment. It is not beyond the realm of probability that dispersed fat, more completely covered with adsorbed protein, would not yield the rich-taste sensation associated with milk fat, but rather a flat, tasteless, chalky

flavor not unlike the flat, tastelessness of fresh, wet casein. The presence of aggregates of protein in milk homogenized at 80° F. but not in that homogenized at 60° and 40° F. as noted under the microscope; the decrease in homogenizative protection against oxidized flavor development at 60° F. and at 40° F.; and the greater susceptibility to the activated flavor at 80° F., but not at 60° or at 40° F.; seem to furnish additional evidence further supporting the theory that greater adsorption occurs on the surface of the solidifying fat globules.

SUMMARY

A thick, viscous chalky-flavored homogenized milk was encountered in processing and distributing bottled, high-testing (4.5 to 4.7 percent fat) homogenized milk.

Plant observations, as well as laboratory experiments, showed that this defect was associated with homogenizing following pasteurization of the vat-cooled milk at a temperature around 80° F. and that the defect was enhanced by longer-than-usual storage.

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THE COST OF MAKING MAPLE SIRUP

By P. W. ROBBINS

SECTION OF FORESTRY

FORESTRY DEPARTMENT extension workers are often asked, "Does it pay to produce maple sirup from the farm woodland?" The answer is "yes, it does pay". High quality maple sirup is always in demand and commands a price consistent with other luxury foods.

The cost of producing maple sirup varies with the season or weather conditions, much the same as weather affects the production of other agricultural crops. Therefore, production costs vary from year to year as the weather affects the extent of the sap flow. A favorable spring of freezing nights and warm thawing days for a period of 25 to 30 days will produce a large sap flow and, consequently, lower the cost of sirup production per gallon. The opposite is true for short seasons like those experienced in 1945 and 1946 when the sap flow was as short as any year on record.

The Michigan State College Forestry Department has kept a record of the cost of making maple sirup in its experimental sugar bush for many years. Since 1930 a detailed cost record has been kept, which is summarized on the basis of cost per gallon sirup.

TABLE 1—*Cost of making maple sirup.*

Operations	1930	1932	1935	1937	1938	1939	1940	1941	1942	1943	1944	1945
Preliminary clean up	$0.05	$0.15	$0.05	$0.07	$0.13	$0.07	$0.09	$0.09	$0.14	$0.10	$0.14	$0.03
Tapping	.10	.13	.07	.12	.19	.12	.12	.19	.26	.15	.20	.23
Collecting sap	.76	.52	.25	.52	.74	.75	.71	.49	.49	.61	.63	1.11
Boiling sap	.58	.63	.38	.59	.82	.49	.51	.31	.57	.41	.44	.47
Final clean up	.06	.18	.02	.08	.09	.08	.08	.06	.09	.10	.07	.10
Fuel (wood) costs	.26	.14	.15	.29	.21	.21	.24	.20	.26	.23	.26	.31
Containers	.18	.14	.14	.11	.11	.12	.15	.13	.14	.16	.15	.15
Depreciation and repairs	.11	.30	.20	.26	.41	.23	.30	.22	.22	.20	.18	.36
Interest on plant at 4%	.06	.17	.09	.21	.33	.19	.25	.19	.22	.16	.15	.22
TOTAL COST PER GALLON	$2.16	$2.36	$1.35	$2.25	$3.03	$2.26	$2.45	$1.88	$2.39	$2.12	$2.22	$2.98
AVERAGE SALE PRICE	$2.28	$2.50	$2.50	$2.52	$2.50	$2.50	$2.53	$2.51	$3.03	$3.39	$3.39	$3.39
TOTAL SIRUP PRODUCED IN GALLONS	185	179	326	149	93	180	144	220	182	250	275	138
TOTAL BUCKETS HUNG	786	783	781	790	700	1000	800	1070	1024	1061	1034	980

ARTICLE 29-20

It will be noted that the costs do not include taxes. Unless the woods is devoted exclusively to sirup production (which is seldom the case) the taxes should be charged against all of the products of the woodlot, such as lumber, fuelwood and wildlife. At any rate, the tax cost would never add more than a fraction of a cent per gallon to the cost.

The sap was concentrated with a steam evaporator in 1932, 1935 and 1937 to 1941, and since 1941 with a fire arch evaporator. Despite increased labor costs in recent years it will be noted that the cost of boiling generally is less with a fire arch evaporator than with steam. The labor rates paid ranged from 35 cents per hour in 1930 to 65 cents per hour in 1945. Team labor was hired at the rate of 20 cents per hour for the team without a driver. The increases in labor costs are reflected in higher sirup costs in recent years. The high cost of producing a gallon of sirup in 1938 was due to the total production being only 93 gallons. In addition to the poor season that year, the steam boiler required extensive repairs, which are reflected in the boiling, depreciation and repair costs.

However, it will be noted that the total amount of sirup produced, which is dependent on weather conditions, is the principal factor in the fluctuating cost of sirup production. So even when labor wage rates were high, as in 1943, the cost per gallon was lower than 1930 because the season was more favorable to the production of sap. The most important point brought out by the data in Table 1 is that the selling price of maple sirup usually has been above production costs.

It can be concluded from the cost and production data presented that the Michigan maple sirup producers usually can make a reasonable profit on the sugar bush even if all the labor must be hired especially for this operation. Indeed, this conclusion is even stronger if the sugar bush is operated in conjunction with the usual farm activities, because part of the labor to tap and operate the sugar bush usually is available at that season of the year without additional expense. Therefore, Michigan farmers who have an adequate stand of tappable sugar maple trees should include sirup making as a part of their farm operations.

EATON OATS

By E. E. DOWN and J. W. THAYER, Jr.
SECTION OF FARM CROPS

THE NEW EATON oat variety was recently introduced to Michigan farmers because of its superiority over other varieties now commonly grown in the state. The combined efforts of the plant breeders of the Farm Crops Department of Michigan State College and members of the Office of Oat Investigations of the U. S. Department of Agriculture made such a variety possible.

The services of members of the Office of Oat Investigations have been of great value to the state experiment stations. Varieties have been collected from all parts of the world and tested for their resistance to disease before being combined or crossed with old varieties for the purpose of producing new and better oat varieties for this country. Material in varying degrees of genetic purity resulting from these crosses was sent to the various state experiment stations for testing, and a large number of the recently introduced varieties have been developed in this manner.

The Eaton variety was developed from a cross made between Bond and Iogold. Bond is an Australian variety resistant to smut and leaf or crown rust. Iogold is a stem-rust-resistant variety selected from a Russian variety, Kherson. These two varieties were crossed because of the possibility of producing a high-yielding, smut- and rust-resistant, stiff-strawed variety with good quality. Eaton possesses all four of these desirable characters. It is characterized by a stiff straw, stem and crown rust resistance, smut resistance, white grain, and high test weight.

Eaton is not resistant to all forms of rust. It is resistant to the same forms of stem rust as Vicland and Marion. It has the leaf or crown rust resistance of the new variety Clinton recently introduced by the Iowa Agricultural Experiment Station. Eaton has a test weight approximately equal to any Michigan grown variety except Huron. Huron loses this superiority when rust is prevalent. It is generally about 4 inches shorter than Huron at maturity and grows 4-6 inches

ARTICLE 29-21

Fig. 1. Oat test plots at East Lansing.
(Picture centered on Eaton.)

taller than Vicland. Its stiffness of straw is outstanding. This characteristic has been demonstrated in over-state oat trials conducted in different Michigan counties. Over-state oat trials definitely show that Eaton is adapted to the entire lower peninsula. These trials also indicate that Eaton may not be adapted to the upper peninsula.

Comparative results between Eaton, Huron, Marion and Vicland obtained at East Lansing given in Table 1 generally agree with the results obtained from over-state trials.

In 1946 it was possible to compare Eaton and Clinton, a new Iowa variety, for the first time. Sufficient seed of Clinton was obtained for six trials. These were grown in central and southern Michigan. Eaton yielded slightly less in two trials and slightly more in four trials. Eaton averaged 87.9 bushels for all six trials. Clinton yielded 85.9 for the same six trials or 2 bushels less. This difference is not statistically significant. On the basis of six trials in one year these varieties did equally well.

TABLE 1—*Agronomic comparisons at East Lansing of Eaton, Huron, Marion and Vicland 1941-1946 inclusive.*

Variety	1941	1942	1943	1944	1945	1946	Average
Yield (bushels per acre)							
Eaton	75.5	95.4	47.9	77.1	85.2	81.2	77.1
Huron	76.8	95.5	37.0	81.0	79.6	84.8	75.8
Marion	66.9	88.0	46.0	77.3	76.8	88.4	73.9
Vicland	71.1	93.9	47.0	74.6	77.0	84.2	74.6
Test weight (pounds per bushel)							
Eaton	35.7	34.0	29.5	35.3	36.4	36.7	34.6
Huron	37.5	36.3	28.8	39.0	37.6	36.8	36.0
Marion	35.2	33.0	32.0	36.3	36.1	37.4	35.0
Vicland	34.0	33.5	29.0	34.2	36.1	36.5	33.9
Date ripe (day in July)							
Eaton	11	18	24	14	26	17	18
Huron	15	20	24	21	26	19	21
Marion	14	18	26	19	26	17	20
Vicland	12	24	24	14	26	17	20
Height (inches)							
Eaton	37	45	40	41	42	44	41.5
Huron	39	50	42	45	45	47	44.7
Marion	37	45	37	41	41	45	41.0
Vicland	34	40	35	38	34	38	36.5
Lodging (percent)							
Eaton	0	4	0	0	0	0	0.7
Huron	0	10	15	0	0	0	4.2
Marion	0	4	15	0	0	0	3.1
Vicland	0	70	0*	0	0	0	11.7

*Too small to lodge.

Fortunately, Eaton is resistant to the new root-rot disease *(Helminthosporium victoriae)* that did so much damage to oats in several states in 1946.

SEED SUPPLY

When a new variety is ready for release by the Section of Farm Crops it is distributed through the Michigan Crop Improvement Association. This is an organization of trained, experienced, farmer seed producers who are equipped to increase foundation seed of varieties they receive from the Section of Farm Crops. This seed is grown under contract between the Michigan Crop Improvement Association and selected growers. The first field of Eaton oats was

grown on the farm of George Moore of Elsie in 1945. A 12-acre field yielded 1,156 bushels of cleaned seed. This seed was grown for certification in 1946. Some 550 acres passed field inspection. It is estimated that 25 to 35 thousand bushels of seed will be distributed in 1947. A list of growers is available through the office of the Michigan Crop Improvement Association.

PORTABLE PIPE IRRIGATION PRACTICES IN MICHIGAN

By F. W. PEIKERT[1]

SECTION OF AGRICULTURAL ENGINEERING[2]

SUPPLEMENTAL IRRIGATION is becoming a standard practice on a number of Michigan farms producing crops having a high return per acre. At the present time practically all the irrigation is by some type of sprinkler system. For field irrigation the quick-coupling portable pipe with rotating sprinklers is most commonly used, and there are about 250 such systems in the state. Figure 1 shows the location of these systems. The amount of land irrigated on individual farms with portable pipe ranges from small plots of several acres up to 80 acres or more. Several farmers have as much as 125 acres under irrigation.

In order to get further information about the field irrigation practices in Michigan, a survey was conducted during the fall of 1946 on 62 farms having portable pipe irrigation systems and which were considered typical of the irrigated farms. The following information is from this survey and shows the irrigation practices that are being followed at the present time.

CROPS IRRIGATED

Supplemental irrigation is proving most profitable on small fruits, vegetables, potatoes, nursery stock and flowers. This past season, with rainfall below normal during most of the growing season, good results were also reported on pastures and tree fruits. However, more data will be required before it can be determined how profitable irrigation will be on these over a period of years.

[1]Professor of Agricultural Engineering.

[2]Assistance was obtained from the Section of Horticulture in obtaining some of the data presented in this article.

ARTICLE 29-22

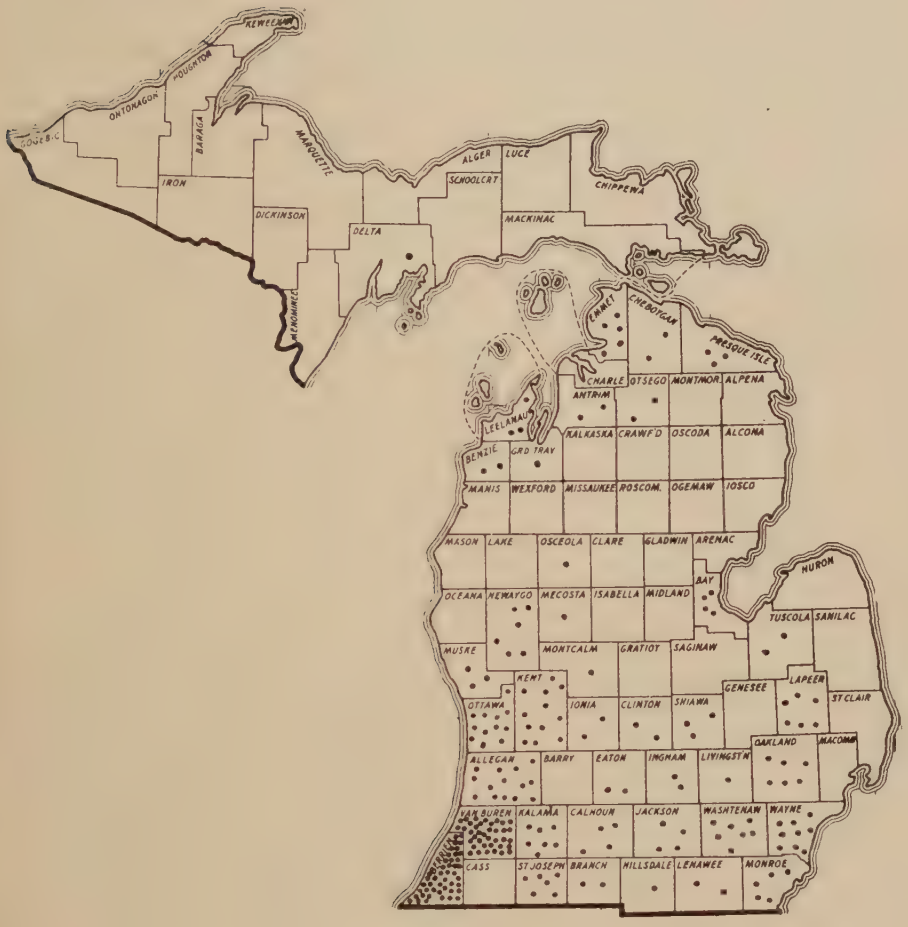

Fig 1. Location of the portable pipe irrigation systems in Michigan.

TABLE 1—*Crops irrigated in Michigan.*

Small fruit	Tree fruit	Flowers	Field crops	Truck crops	Pastures
Raspberries Strawberries Blueberries	Apples Peaches Cherries	All types, especially tulips and gladiolas	Potatoes Beans Sugar beets Peppermint	Tomatoes Celery Cucumbers Peppers Cabbage Cauliflower Egg plant Onions Spinach Carrots Squash Sweet corn	Alfalfa and brome grass

Table 1 shows the different crops being irrigated in Michigan. Those with the greatest acreages under irrigation are strawberries and potatoes.

VALUE AND COST OF IRRIGATION

Yield Due to Irrigation

One of the most important factors in irrigation is the increased yield that can be expected over that of crops not irrigated. Of the 62 farmers contacted, 50 made reports and all these indicated an increase in yield as shown below. The others did not have any definite information on which to base their comparisons.

Yield	*Farmers reporting*
Much better	41
Better	5
50% increase in yield	3
300% increase in yield	1
	50 reports

The average increase in yield is difficult to determine because of the terms used by the farmers in reporting. It will also vary from one season to another and with the different crops. However, as this survey was intended to give the indications or trend, the foregoing phraseology is satisfactory and shows that the farmers believe that irrigation greatly increases the yield. In some instances it was reported that the returns from the increased yield paid the cost of the irrigation system in the first year of use.

Quality of Crops Under Irrigation

Another purpose of supplemental irrigation is to produce a high quality product. The following is a summary of the reports received:

Quality	*Farmers reporting*
Much better	35
Better	10
Very good	5
Good	4
	54 reports

Of the 54 farmers reporting on this question, all agreed that supplemental irrigation improves the quality of the product.

Earliness of Crop Due to Irrigation

There is considerable difference of opinion on the effect irrigation has on the time of crop maturity. Sixty-six percent of the reporting farmers say that crops mature the same time as without irrigation; 15 percent say that their crops mature up to 10 days earlier owing to irrigation, while 19 percent say that their crops mature later under irrigation. Before any definite conclusions can be reached as to the effect of irrigation on time of maturity, further investigational work will be required. Following is a summary of the reports received:

Time of maturity	*Farmers reporting*
No earlier	27
Week to 10 days earlier	6
Later	8
	41 reports

Cost of Equipment and Returns

Table 2 shows the cost of equipment as compared with the returns from irrigation. In the equipment cost was included the pipe, sprinklers, pump and power unit. An attempt was made to get the average added returns per acre over a period of years, but in reviewing these figures it must be remembered that the reports were obtained from farmers during the fall of 1946, following for the most part a season of unusually dry weather and good prices. For that reason, the returns due to irrigation, as reported, are probably somewhat higher than can be expected for an average year.

TABLE 2—*Average cost of irrigation equipment as compared to the added returns from irrigation.*

Range of acreage per farm under irrigation	Type of soil	Number of farms reporting	Total acreage	Average acreage irrigated per farm	Average cost of equipment		Average added return per acre due to irrigation
					Total	Per acre	
55–125	Sandy loam or sandy	13	1044	80	$5050	$ 63	$ 60
25–54	Sandy loam or sandy	16	600	38	3300	88	70
2½–24	Sandy loam or sandy	21	242	12	2000	176	122
5–125	Muck	8	289	36	1800	50	35

It can be seen from Table 2 that as the acreage under irrigation per farm increases the cost per acre for equipment decreases. However, it should also be noticed that, on the average, the added return is the largest on farms with the fewest number of acres under irrigation. This is probably due to the more intense farming practices on highly specialized crops.

The considerably lower average added returns per acre reported by muck farmers may be attributed to the fact that they use irrigation on muck lands primarily after planting to give the crop a good start. After the crop is once established on muck it is not so likely to suffer during drought periods as is the case on light, mineral soils.

ANNUAL COST OF IRRIGATION

In determining the total cost of irrigation, it is necessary to consider the cost of labor, power to operate the pump and the fixed charges on the equipment.

The following is a typical example of the cost of irrigating 40 acres six times during the season with one inch of water per application. The average cost of a system to cover the area in 48 hours of operating time is estimated at $3,450. The costs for power and labor are the average reported for the state at the present time.

Example:

Cost of irrigation per season

Acres irrigated	40	
Operating time per irrigation (hours)	48	
Irrigations per season	6	
Labor	60c per hour	
(Two man-hrs. per acre for each irrigation)		
Power (considering gasoline engine)	65c per hour	
(Cost covers fuel, oil and repairs)		
Estimated life of equipment	10 years	
Operating costs		
Labor 2x40x6x60c		$288.00
Power 6x48x65c		187.20
Total operating costs		$475.20
Fixed costs		
Depreciation 10% of $3,450		$345.00
Interest (5% on average value)		86.25
Total fixed costs		$431.25
Total annual costs		906.45
Annual cost per acre to irrigate—about		22.00

APPLICATION OF IRRIGATION WATER

Sources of Water

From the survey it was found that the greatest number of farmers in the state obtain their water from streams with lakes and wells also serving as important sources of supply:

Source	*No. in use*
Streams	36
Lakes	12
Wells	12
	60 reports

Use of Wells

In some areas farmers are able to get sufficient water from shallow wells and this is usually an economical source of supply, especially when the well can be located near the center of the field.

If it is necessary to drill a deep well, as much information as possible should first be obtained as to the probable depth to water, the flow per minute and the probable drawdown. The sources of such information are either the State Geologist's office at Lansing or experiences of well drillers who have worked in the area. In localities where sufficient information is not already available, it is advisable to first drill a test well.

Amount of Water Required

The rate at which water must be pumped depends upon the acreage irrigated and the time allowed to cover the area. It requires about 30,000 gallons to apply an inch of water on an acre. A farmer should have a system large enough to cover the area in about a week or from 48 to 72 hours, actual operating time. A pump delivering 450 gallons per minute will supply an acre-inch per hour.

The usual practice is to put on from 1 to 1½ inches of water per application for the more shallow rooted crops grown on light soils. (See Table 3.) On some of the deeper rooted plants, such as alfalfa and fruit trees, applications of 2 to 2½ inches are made. It is desirable to apply only enough water so that the soil moisture is brought

TABLE 3—*Irrigations per season and amount of water per application.*

Crop	Average number irrigations per season	Average application inches per irrigation
1. Small fruit	6	1⅓
2. Flowers	9	1¼
3. Field crops	5	1¼
4. Truck crops	5	1½
5. Pastures	no data	2

up to field capacity to the depth of the principal feeding roots of the plant. Over-irrigation should be avoided as it is not only an unnecessary expense but may also tend to leach out the plant nutrients in the soil.

Number of Irrigations per Season

Table 3 shows the average number of irrigations per season on the farms covered by the survey. The number of irrigations in any season will depend on the distribution of rainfall, but it has been the farmers' experiences that there is some time during virtually every season that supplemental irrigation can be used to advantage. One farmer in Van Buren County states that he has found it advisable to irrigate 16 out of the past 17 years.

IRRIGATION EQUIPMENT

Portable Pipe with Rotating Sprinklers

For field irrigation, most farmers are using a quick-coupling galvanized pipe with a number of rotating sprinklers as shown in Fig. 2. This pipe comes in 16- and 20-foot lengths and ranges from 2 to 8 inches in diameter. The proper size of pipe to use depends on the length of line and the amount of water per minute that must be conveyed. The proper pipe size must be determined for each installation.

The common arrangement for the pipe is to have the main line either along one side of the field or through the middle with one or more laterals having rotating sprinklers spaced 40 to 60 feet apart. After a strip is irrigated, the lateral is moved to a parallel position 60 to 80 feet away. This procedure is repeated until an entire field has been covered.

Some farmers are using a single lateral and shutting off the pump while the pipe is being moved. This arrangement will require the

Fig. 2. Portable pipe irrigation system in operation.

least pipe and is satisfactory, provided the acreage to be covered is not too large. The pump is usually shut down about 30 to 45 minutes while the line is being moved.

On larger areas the usual practice is to have enough pipe so that one line can be moved while the water is running in the other. In that way the pump can be operated continuously.

Pipe 4 inches or less in diameter is light enough so that it can be readily moved by one man although two men are often used on the 4-inch size and almost always on larger sizes.

The amount of labor required was found to average about 2 man-hours per acre for each irrigation. This was true for the larger as well as for the smaller installations.

On the smaller installations, tended by one person, it is felt that a man should remain nearby while irrigating even though his full time is not required in moving pipe. On the larger systems two men are ordinarily used but their time is quite well utilized in moving the lines.

The life of the portable pipe has not yet been determined, as most of the systems have been in use only a few years. All the different types of pipe observed in the survey were still in good condition and the farmers did not express any dissatisfaction with their pipe. All the different makes seemed to be giving satisfactory service.

One farmer has been using 18-gage pipe for the past 9 years. This pipe was carefully examined and found to be in excellent condition. At the end of each season, the owner carefully checks each length and coats any places where the galvanizing has been broken. The rubber gaskets are all removed and cleaned before storage. Then the pipe and other equipment is stored under cover during the off season. The owner estimates that his equipment should last 15 or 20 years.

Aluminum Pipe

There is at present considerable interest in the use of aluminum pipe for irrigation. As far as known, none has yet been installed here in the state, but there probably will be some available this next season. Apparently it will be priced approximately the same as galvanized pipe. The principal advantages of aluminum pipe are its light weight and resistance to corrosion.

Sprinklers

The sprinklers in use are all of the rotating type and commonly operate at a pressure of 30 to 40 pounds per square inch. These sprinklers are usually spaced at 40- or 60-foot intervals in the line if 20-foot lengths of pipe are used and spaced 48 or 64 feet on pipe that comes in 16-foot lengths. Sprinklers with capacities of 5 to 40 gallons per minute are the more common although a few go as high as 90 gallons per minute capacity. Several sizes of nozzles are available for each. In order to have approximately uniform distribution of water, the sprinklers are spaced in the line about equal to the radius of the circle covered.

Single High Pressure Sprinkler

There is considerable interest at present in a large single sprinkler having up to 450 gallons per minute capacity to replace the smaller sprinklers indicated above. This unit covers over an acre at a setting. Several of these large sprinklers, mounted on a two-wheel

carriage to facilitate moving, were in use during the past season. The principal advantage claimed for this type unit over the conventional sprinklers is the saving in labor. Since the large sprinkler covers such a large circle, the portable supply pipe need not be moved as often in order to cover the field. The disadvantage to the large single unit is that it must operate at about 80 to 100 pounds per square inch pressure at the nozzle as compared with a pressure of 30 to 40 pounds per square inch for the conventional sprinklers. This higher pressure means more power required with a corresponding increase in fuel consumption, which largely offsets the saving in labor.

Perforated Pipe

Another type of portable irrigation equipment used in Michigan is quick-coupling perforated pipe. It has a series of closely spaced holes all along its length, through which the water is distributed a distance of about 20 to 25 feet on each side of the line when the pressure is 20 pounds per square inch. This pipe has been used satisfactorily in orchards as well as for field and truck crops.

PUMPING PLANTS

When water is taken from lakes, streams or shallow wells, horizontal centrifugal pumps are commonly used. For wells where the water is more than about 22 feet below the surface while pumping, deep well turbines are usually required.

The types of power units used on the farms studied are as follows:

Type power unit	*Number*
Automobile engines	29
Tractors	12
Engines—direct connected to pump	11
Electric motors	8
	60 reports

As indicated above, automobile engines are the most common source of power. If new engines of this type are used and not operated at more than about 50 percent of maximum capacity, they are quite satisfactory for pumping plants. The use of old automobile engines for irrigation pumps is not recommended.

The principal objection expressed by farmers to the use of tractors for pumping is that the tractor is usually needed for other work when it should be used for irrigation and the result is that the irrigation may be delayed.

The recent trend has been to the use of industrial-type engines connected to the pump by a short drive shaft and to units in which the pump and engine are assembled as an integral unit. Both types are often made portable and are proving very satisfactory.

Where three-phase electric power is available, the electric motor is a very desirable source of power, especially for driving deep well turbine pumps.

DORMANT TREATMENTS FOR THE CONTROL OF THE CHERRY CASEBEARER

By O. H. HAMMER[1] and FRANKLIN SHERMAN III
SECTION OF ENTOMOLOGY

THE CHERRY CASEBEARER (*Coleophora pruniella* Clem.) is a comparatively new pest of the sour cherry. It increases periodically to heavy infestations which cause serious damage to cherry foliage and fruit. Cherry casebearers, the adults of which are small moths, pass the winter as immature larvae within leathery cases attached to branches, usually clustered in the axils of spurs or buds. Except for a short period after hatching, the larva is always protected by the case which it carries during its period of feeding and growth. As the larva grows it enlarges the case. In the spring when the cherry blossom buds are in the "balloon" stage the overwinter larvae move from the bark to the opening buds. In 1946, an "early" season, this migration was at a peak from April 19 to 24 at Traverse City. Pupation occurs within the case which remains fastened to bark or leaves.

This insect causes damage by (1) eating blossoms and thus reducing fruit-set, (2) feeding on the fruits, causing some to drop and others to be blemished and (3) feeding on the leaves. A larva attaches its case, eats a hole into the leaf and feeds on the tissue between the upper and lower leaf layers. Leaf areas may be "mined" from each point of attachment and such areas often dry and fall out.

The standard control treatment has been a dormant application of oil to kill the larvae before they migrate to the opening buds. Frequent inquiries about other materials and the desire to test new products prompted the initiation of the experiments discussed here and which were carried out in 1946 in the Montmorency orchard of Mrs. Marshall Pratt, north of Traverse City on the Grand Traverse Peninsula.

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ARTICLE 29-23

MATERIALS

Three types of treatment were used: (1) petroleum oil alone, (2) dinitro materials in or with petroleum oil and (3) dinitro materials in water. The materials used are here listed.

D-614—An emulsible oil containing 98.3 percent Sinclair Paraffin Oil No. 1 and 1.7 percent emulsifier.

Dowspray Dormant No. 3—A DN-oil material containing 4 percent dinitro ortho cresol and 96 percent petroleum oil. It contains a goulac-bentonite emulsifier.

DN Dry Mix No. 2—A wettable composition containing 40 percent dinitro ortho cresol.

Elgetol—A slurry of sodium dinitro ortho cresylate containing about seven ounces of dinitro ortho cresol in each quart.

D-289—A solution of the tri ethanol amine salt of dinitro ortho secondary butyl phenol containing eight ounces of actual DNOSBP in each quart.

G-562—A solution of the ammonium salt of dinitro ortho secondary butyl phenol containing eight ounces of the salt in each quart. The sprays were applied on March 20 and 21, 1946.

OBSERVATIONS

Insect control counts were made on June 4 and 5 near the end of the feeding period of the over wintered larvae. Control data and observations on injury to buds are listed in the following tabulation.

TABLE 1

Materials	Amount in 100 gal.	Insect control (percent)	General observations
Emulsible Oil (D–614).....	5 gal.	92.9	Slight retardation
Dowspray.....	1½ gal.	98.1	No injury
Dormant Nc. 3.....	2 gal.	97.5	No injury
DN Dry Mix No. 2.	30 oz.	99.6	No retardation of lateral buds
Emulsible Oil.....	2 gal.		A few terminal buds were killed.
Elgetol.....	2 qt.	99.9	General retardation noticeable for several weeks and some terminal and lateral buds killed.
Emulsible Oil.....	3 gal.		
DN Dry Mix Nc. 2.	3 lb.	99.0	No injury
	2 qt.	99.8	No injury
D–289.....	3 qt.	99.5	No injury
	4 qt.	99.5q	Slight retardation of lateral buds and a few terminal buds killed.
G–562.....	3 qt.	99.2	No injury

DISCUSSION

Oil sprays used at 5 percent concentration may be expected to give satisfactory control if thoroughly applied but there are indications that this treatment is marginal for both insect control and injury to buds.

DN-Oil (Dowspray Dormant) caused no injury at 2 percent but was equally effective at 1½ percent. The lower concentration will also control the black cherry aphis.

DN Dry Mix No. 2 with 2 percent of oil in a rather heavy depositing emulsion (D-614) gave excellent control but caused some bud injury.

Elgetol with 3 percent of the same oil also gave excellent control but caused more injury than the Dry Mix with 2 percent oil. These results are in line with much data from the use of DN materials with oil on apples which have indicated that DN with 3 percent oil is often unsafe.

Three DN materials in water gave excellent control and were safe at effective concentrations. Included were DN Dry Mix No. 2 at 3 pounds and D-289 at 2 quarts per 100 gallons. G-562 was used at 3 quarts in 100 gallons.

Thorough Spraying

Control of casebearer is not possible without complete coverage. None of the materials discussed in this report are effective if not so used.

SHELL TREATING AND MAINTENANCE OF EGG QUALITY IN STORAGE

By J. A. DAVIDSON
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THE SHELL in which the hen encases her product, although it seems to be an acceptable package for commercial handling, actually, was not designed for this purpose. The egg shell was planned by nature to protect the egg against destruction during incubation of the embryo. It was made porous so that respiration by the embryo could take place. The shell is a poor package material, not only because it is fragile, but because it allows the escape of moisture and passage of micro-organisms which result in the loss of that elusive characteristic—quality. An egg is a food product which, similar to many others, does not improve with age—like cheese or wine. It starts to deteriorate as soon as it is laid.

According to Stuart and McNally (1) as well as Mallmann (2), shell eggs are generally sterile when laid. The exception to this general situation occurs when certain pathogenic bacteria may be present in eggs laid by hens suffering from disease. An example is the organism *Salmonella pullorum*. Other bacteria causing rots and other forms of spoilage have been isolated by other investigators, but the frequency of their occurrence is so small that they can be considered negligible.

EGG QUALITY

Jull (3) defines the term quality as applied to market eggs as "that condition of shell and contents which can be marketed in such a manner as to give the greatest satisfaction to the consumer." Wilhelm (4) would restate the definition to include the producer as "that condition of shell and contents which can be marketed to increase the market value to the producer and the nutritive or esthetic value to the consumer".

ARTICLE 29-24

Swenson, Slocum and James (5) attribute the loss in quality to first, a loss of moisture; second, absorption of foreign or off-odors; third, a continuous loss of carbon dioxide which increases the alkalinity of the egg white; and fourth, the decrease in hydrogen ion concentration due to the loss of carbon dioxide. The last-named factor produces a more favorable condition to support the activity of the proteolytic enzyme normally present in the thick white. In addition to the physical and chemical changes pointed out by Swenson and his associates, Sharp and Powell (6), showed that there is diffusion of water from the white through the yolk membrane to the yolk with a change in the pH of the yolk from the acid side. The pH of the egg white is approximately 7.4 to 7.6 when it is laid. At room temperature it will reach 9.4-9.5 in a week. In cold storage temperatures with little ventilation and the storage full it will reach about 8.8-9.0 in 3 months.

The rate at which deterioration of egg quality takes place depends upon the kind of environment under which the egg is kept. It is therefore impossible to state in terms of time when an egg is a fresh egg or when it is stale. Thus, any procedure which will stop or slow down physical and chemical changes in the egg will help to maintain the quality inherent in the egg.

SHELL TREATMENT

Shell treating as a means of controlling microbial invasion, loss of moisture, or loss of carbon dioxide, thus preventing the increase of alkalinity, may be warranted if the improvement in the maintenance of quality is greater than the cost of the treatment. In broad definition, shell treating might include washing with water in which chemicals with or without bactericidal properties are included, thermostabilization or pasteurization with water or oil, and greasing or oiling (hot or cold) with or without an antibiotic agent. Possibly sand blasting should also be included. Generally, shell treating in the trade means the use of oil in some form. The term "processed" also occurs frequently in the literature and considerable resistance to the use of eggs which were labelled "processed" was and still is encountered in some quarters probably due to the quality of eggs which were treated.

Use of oil to preserve eggs is not new. Early in the 19th century (7) Dutch farmers preserved eggs for the winter season by dip-

ping them in linseed oil. Benjamin Franklin (8) supplied vessels with eggs that had been treated with oil. In those days it is probable that flavor was less important than the nutritive value, and curry powder will cover up any bad flavor.

In 1920, Jones and DuBois (9) recommended the use of an aluminum soap which was applied in a gasoline solution after preliminary sulfuric acid treatment. In 1922, Almy, Macomber and Hepburn (10) believed mineral oils to be superior to vegetable oils, and found the heavy mineral oils to be more effective than the lighter ones when applied at 239° F.

In 1928, Howard (11), of the Clairemont Sterilized Egg Company, stated that "shell treating eggs is admitted to be the one and only means of stabilizing and standardizing egg quality. Each year improvements in machines and methods of treating eggs have been made, producing more perfect results, until at the present time there is little left to be desired. The best temperature and best length of time for the dip have been determined by years of experiment, and a perfect solution for dipping eggs has been developed".

Morford (8), 1933, of the DeSoto Creamery stated that oiling was being done by immersion or spraying at 100° to 240° F. Swenson (5) claimed that his vacuum carbon dioxide system of oiling was more effective in the prevention of moisture loss. Loss by submersion was 16 times greater and unoiled loss was 27 times greater. Morford reported on eggs covered with a grease or paste when eggs were 24 hours old. After 2 months in storage, 74 out of 171 graded A, 61 B+, 35 —B, and one rot. Another lot kept at 70° for one week longer graded approximately the same. He was not favorable to its use because of the smeary appearance. Another report in 1933 stated that due to the lack of consumer acceptance oiling was none too successful.

Slocum, Lee, Swenson, James and Steinbarger (12) studied the flavor of oil-treated stored eggs in 1933. The eggs were hennery whites from Nebraska, stored in March after treatment with four different oils varying in viscosity and pour points. One oil had an asphalt base. The others had a paraffin base. They state that deteriorative changes in eggs during storage, showing low grade before the candle, are not necessarily accompanied by off-flavors, and conversely storage eggs may be graded high by candling and may still possess objectionable flavors. They further state that colorless, tasteless, and odorless mineral oils of widely different specific gravities

and pour points do not adversely affect egg flavors during storage.

In 1935, Sharp and VanWagenen (13) examined several lots of middle western oil-dipped eggs which were found to be low in quality. They point out that if oil-dipping is to exert a preserving effect other than to retard the escape of moisture, the egg must be oil-dipped before too much of the carbon dioxide has escaped from the egg. The pH values showed that much of the CO_2 had escaped before oil treatment of the eggs.

Swenson, Slocum and James (5) in 1936, reported the use of cold oil. After 8 months' storage 32.5 percent of unoiled lot remained in original grade, 65.8 percent of eggs oiled at 60° F. and 56.6 percent of eggs oiled at 80 F. remained in the original grade. Using the vacuum carbon dioxide method the percentages of original grade for 60° F. and 80° F. were 88.9 and 64.1 percent respectively. The oil used had a pour point of 40° F. and a viscosity of 50-60 at 100° F.

Hoover (14) in 1939, reported a method of measuring the oil contents of the shell. A wide variation in the oil content of the individual processed eggs was observed. This may be one reason for inconsistent results in commercial practice.

In 1942, Evans and Carver (15) reported that oiling eggs as soon as they were gathered best preserved their interior quality when stored for one week at 64°-70° F. Eggs oiled within 5 hours of the time they were laid had the albumen index best preserved when they were stored for 3 months at 32° F. Eggs oiled the day after gathering were superior to the other two when all criteria were considered. Evans reported that the use of a solvent with a low boiling point and a high viscosity oil in equal parts was as effective as the oil alone. For storage for 4 weeks in room temperature (60-70° F.) an oil with a high viscosity was better than a less viscous oil.

In 1945 a representative of the Seymour Packing Company (16) stated that oiling shells had become almost universal for quality eggs, and that in the future it may be done to a certain extent by the producer. Schauret (18) in an article, "Oiling Protects Quality," stated that oiling does a great deal to maintain quality. He also said that rapid chilling, especially if warm oil is used, further helps to maintain quality, that there is no secret process for oil dipping, and that the entire process can be done without specially trained help.

USE OF ANTIBIOTICS IN OIL

In 1944, Mallmann and Davidson (19) reported on the use of an oil containing an antibiotic (0.25-percent penta chloro phenol). Eggs so treated, which were held for 71 days at room temperature in Mason-type jars with a small amount of water so that high humidity prevailed, failed to show any mold growth. Eggs were purchased from a local receiving station and at the same time 24-hour-old eggs were obtained from the Michigan State College poultry plant. Both lots were stored in the same storage room at 31 F. At 8 months the eggs were broken and placed in pint Sealright paper cartons and frozen. Borings were collected and tested to determine bacterial content. The bacteria counts of these untreated eggs ran from 108 to 130,000 bacteria per gram for the 24-hour-old eggs, while for the receiving station eggs the counts ran from 1,900 to 3,300,000 bacteria per gram. This shows that under practical storage conditions bacterial invasion occurs largely before storage, provided, of course, that storage conditions are not conducive to bacterial development.

Eggs treated with varying concentrations of 0.1 to 5 percent of penta chloro phenol in oil were stored for periods of 6 months or more. Some were held as long as 14 months without mold or bacterial spoilage when fresh eggs (48 hours or less) were treated.

Samples of these eggs were submitted to the Home Economics Foods and Nutrition Department for taste determinations. The test failed to detect any changes in quality that might be attributed to the treatment of the egg.

Current receipts and fresh eggs (48 hours old) were oiled with an oil containing 0.25 percent penta chloro phenol. After 9 and 12 months' storage, respectively, the eggs were broken out aseptically, mixed and frozen in pint Sealright cartons. Samples were collected from each package and examined bacteriologically. The bacteria counts on the eggs from the receiving station ran from 140 to 5,900,000 bacteria per gram and from the 48-hour-old stored eggs they ran from 20 to 2,300 bacteria per gram.

If microbial spoilage is to be prevented, treatment must take place at the source as soon as possible after the egg has been laid.

OILING ON THE FARM

Eggs, approximately 24 hours old (this eliminates cloudy whites), are dipped into a light paraffin oil (viscosity 50-60) containing 0.25

percent penta chloro phenol at room temperature, preferably 70° F. They are then drained and packed as usual, an operation which can be performed by the farmer or poultryman. It is impossible to overtreat an egg with cold oil.

Dirty eggs may be washed without endangering their keeping quality, provided they are dried and immediately dipped in the treated oil.

The process should be applied to all eggs irrespective of their ultimate use. The use of the process for eggs left in wet, dirty nests for several hours or days during warm weather may help, but it is not a short cut to permit poor poultry practice. The method may be useful in the receiving station, as the treated eggs should be better able to withstand poor storage conditions because the antibiotic agent on the shell prevents invasion of the shell by molds and bacteria.

COMMERCIAL PRACTICE IN PROCESSING SHELL EGGS

(A Report of the Shell Egg Committee of Institute of American Poultry Industries. *U. S. Egg & Poultry Magazine*, Vol. 48, p. 302.)

"Never process eggs which have been under refrigeration.

"1. All eggs should be candled and graded (Be sure to take out every check, weak-shelled, stained and dirty egg.), and all eggs should be thoroughly dry before processing to prevent spots in the shell membranes.

"2. Eggs which have been candled and graded for processing should be placed in strictly new fillers, flats, and cases, exercising special care to keep out any feathers, dust or dirt particles. Keep processing machine covered while not actually in use.

"3. The temperature inside the eggs being processed should not be less than 50° F. (Temperature can be determined by inserting thermometer into the center of an egg.)

"4. The temperature of the oil during processing has wide variance in commercial practice. Much depends upon the kind of processing equipment used. The committee feels also that much depends upon the kind of oil used, the type of machine, the length of dipping, and manufacturers' recommended methods.

"(a) Use oil of 50 to 60 viscosity at 100° F. and specific gravity 830 to 840 at 60° F. Make a 12-second dip at a temperature of 115° to 125° F. and drain for 45 seconds.

"(b) Use oil of 50 to 55 viscosity. Keep temperature of oil 140° to 160° F.

"(c) Use oil heated to 125° to 130° F. Temperature of oil is not important within reasonable range of temperatures except for economy in amount of oil and reducing or lessening appearance of oil on treated eggs.

"5. Operators have various methods for oil sterilization and cleaning. A few of the procedures in use are:

"(a) At the end of the day's processing run, the temperature of the oil left in the tank should be raised to 160° F. The oil should be strained through several thicknesses of cheesecloth and then placed in a dust-proof container for use the following day. The oil pan and conveyor on processing machine should be cleaned thoroughly after the oil tank has been emptied.

"(b) The oil should be changed daily or after 1,000 cases of eggs have been shell treated.

"(c) It is important to filter thoroughly the used oil. Some operators strain the oil through a very fine silk cloth, then heat the oil and hold it a certain length of time (depending on temperature) to effect thorough sterilization.

"(d) Follow manufacturer's direction.

"6. Several methods are followed in handling eggs after processing. One operator immediately puts the eggs in the refrigerator, while another makes it a practice to have eggs stand for 12 hours (to allow further drainage before oil hardens) before placing them in colder temperature."

COOKING PROPERTIES

The discussion of this subject would not be complete without saying something about the cooking properties of eggs that are shell-treated with oil. The Washington Agricultural Experiment Station (20) reported on some comparative studies of the culinary and

physical properties of eggs in order to determine the best time for shell-treating eggs that are to be stored. Their information indicates that the eggs should be processed the day after gathering. Eggs treated immediately at noon and evening of the day gathered were not so good as those processed the day after gathering, but were considerably better than eggs stored 5 months without treating. In their study the eggs were poached and boiled and were scored for flavor, texture, color and appearance. They also reported, as have others, that the treated eggs were more difficult to peel, but the stored eggs were no more difficult to peel than eggs a few hours old. Others have reported this same difficulty. Swenson and James (21), in 1932, stated that oiling does not make the shells of eggs more brittle as has been mentioned by others as a cause of the cracking encountered when cooked in the shells. Perhaps cooling should be done by blowing cool dry air over the eggs to cause a greater loss of moisture for 24 hours.

It should be pointed out that Sharp and Powell (6) found that the selective permeability of the shell membrane is of high order, since in eggs stored for two years in waterglass there was no change in the pH due to any diffusion of the alkali. Therefore, there should be no hesitation to immersing eggs in an odorless and colorless oil.

FACTORS AFFECTING EGG QUALITY

While it is not within the province of this discussion to cover factors which affect interior quality, it is necessary to mention them so that we may see the relation between shell treating and the maintenance of egg quality in storage. These factors are time, temperature, humidity, inheritance, ration, and handling. Seasonal loss has also been mentioned, but that is included in time, temperature and humidity. The detailed effects cannot be discussed here since they have either been discussed elsewhere or are generally known by most handlers of eggs. The reason for mentioning them at all is to point out that the evidence available shows that oiling does not improve the quality but it is a tool, if properly used, which will aid in the maintenance of quality even for eggs that are not stored for any great length of time. This is particularly true during the normal season for storage of surplus stocks.

Therefore, it seems that the proper time for oiling is on the farm as a regular practice. Those eggs likely to be stored, possibly should

be gathered daily by truck and processed at the receiving station in a similar manner as whole milk is handled. If too much time elapses before treatment, the treatment from the evidence available is of little value except for the prevention of rapid loss of moisture. So far as flavor is concerned and generally from the standpoint of microbial invasion, the damage has already occurred. The treatment is then condemned.

We cannot minimize the problem of oil contamination, but it seems that with a minimum amount of effort, the oil can be filtered so that the chance of contamination is much less than that encountered under present handling methods. Mallmann and Davidson (22) did not encounter any unusual amount of bacteria in oil used day after day for a period of 30 days. Usually the oil was sterile in 24 hours with no treatment of the oil at all. It must be remembered that they were using enough oil to dip 180 eggs in a wire basket at one time, and only once a day.

Earlier it was mentioned that the flavor of eggs is not correlated with the grade determined by candling. It may be well to point out that the early initial invasion of micro-organisms cannot be determined by candling. Eggs that seem of good quality, determined by candling, may eventually when subjected to poor handling or poor storage conditions show poor quality or become inedible. This change in quality is due to the multiplication of the organisms already on or in the egg.

Then, too, the washing of dirty eggs might be solved to a certain extent, since it has been found that washing, drying, and immediately immersing in oil did not show any bad effects. Funk (17) has stated that oiling washed eggs gave 5 to 20 percent higher retention of grades than those which were not treated.

THERMO-STABILIZATION

This discussion would hardly be complete without mentioning thermo-stabilization and pasteurization which may be done with water, but can be done best with oil. Barott and McNally (23) reported in 1943 that temperatures from 129° to 142° F. may be used, but at the higher temperature the time must be accurately controlled to prevent coagulation. Also, the coagulation point is dependent on the pH value of the egg contents. If properly applied to fertile eggs the process results in sterilization from the viewpoint of embryonic

growth, 4 minutes at 144° F. to 44 minutes at 124.5°. Barott and McNally emphasized the need for thorough knowledge of immersion time necessary at various temperatures to produce the desired results. It is obvious that during the summer months, when most of the eggs are available for storage, the processing should take place as soon as the egg is laid. Therefore, it is too complicated for use by any egg producer except the very large poultry farm. The same amount of money paid out for refrigeration equipment and the elimination of the male birds would give more predictable results.

Funk (24) also has worked on the same problem and reports that it stabilizes the thick albumen so that when oil is used the eggs can withstand high temperatures for a longer period of time and, when stored, the thermo-stabilized eggs retained their quality much better after removal than untreated ones. He further states that the heat treatment reduced the bacterial content of liquid eggs by 95 percent. The keeping quality of eggs held in storage was much improved. He attributes half of the improvement to oiling and the other to the heat treatment.

The question of heat-treating or thermo-stabilization is interesting and may with further study, together with the development of suitable, inexpensive equipment, be adaptable for use on the farm where it will maintain top quality.

It would seem, therefore, that for the present at least, maintenance of quality depends upon proper care of the egg as soon as it is laid and the use of oil treating at the proper time. This may mean revision of assembling practices or the application on the farm. The establishment of such practices may lay the ground work for the promotion of thermo-stabilization or some new application or new method of preservation of egg quality.

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ECONOMIC VALUE OF OIL-WAX EMULSION SPRAYS IN CHERRY ORCHARD PRACTICES

By A. L. NEAL, V. R. GARDNER, E. J. RASMUSSEN and E. J. MILLER*

SECTIONS OF AGRICULTURAL CHEMISTRY AND HORTICULTURE

DURING AN INVESTIGATION pertaining to the application of oil-wax emulsion sprays for horticultural uses, it was observed that these materials were responsible for producing larger cherries when applied to bearing Montmorency cherry trees (1). In this preliminary experiment a 7-percent increase in the weight of the fruit resulted from the use of one application of an oil-wax emulsion containing a fungicide to trees growing on cultivated land. When two and three applications were made the increase amounted to 15 and 35 percent, respectively. Since the emulsion was used at a dilution of 1 to 100 and was applied with the customary fungicide according to the regular spray schedule, the additional cost of using this material would be quite small when compared with the net increase in returns which would have been obtained from an average yield of fruit. With the idea in mind of using oil-wax emulsions on a commercial scale for increasing the size of cherries, field trials were conducted in order to determine the economic advisability of such treatments. In view of the fact that the foregoing phenomenon has been confirmed not only by the Michigan Agricultural Experiment Station (2) but also by two other experiment stations (3), it seems advisable at this time to make a brief summary of the economic value of the use of these materials in cherry orchard practices.

ECONOMIC VALUE

Obviously, the economic advisability of using these emulsion sprays will be governed by the increase in the size of the fruit as compared with the prevailing price for such a commodity and the cost of the emulsion.

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ARTICLE 29-25

In order to obtain a general appreciation of the economic value of these emulsion sprays let us consider the results obtained from test plots, designated as A, B and C, in three separate cherry orchards in which different orchard practices were used. Although it is not strictly permissible to compare data obtained under such variable conditions, for this purpose it will serve as an indication of what might be expected to result from the use of two applications of the emulsion sprays.

The increase in the weight of the fruit from these three plots ranged from 7.6 to 12.9 percent and averaged 9.8 percent. If it is assumed that this value is representative of the increase which would have been obtained had the emulsion been used on a commercial scale, the net increase in returns would have approached $130 per acre at the highest 1946 market value for sour cherries in Michigan.

The variations in the orchard practices in the foregoing groups were as follows: The trees in plots A and C were growing on cultivated land and those in plot B were on sod. In plots A and B both applications of the oil-wax emulsion were made as a separate spray treatment, whereas, in plot C they were applied in combination with the fungicide for the second and third cover spray.

Since the market value for cherries in subsequent years will undoubtedly be lower than it was this past year, it is of prime interest to compare the net increase in returns per tree or per acre at various market values. To illustrate this point the following table was prepared:

Fruit price per pound	Increase in weight of fruit percent	Net increase in returns	
		Per tree	Per acre
$0.15	10	$1.30	$130.00
0.10	10	0.80	80.00
0.05	10	0.30	30.00
0.04	10	0.20	20.00
0.03	10	0.10	10.00
0.02	10	0.00	0.00

As a basis for the calculations in the foregoing table it was necessary to make the following assumptions: 1, two applications of the emulsion spray in combination with the fungicide were made during the fruit growing season; 2, five gallons of spray mixture was applied to each tree at each application; 3, there were 100 cherry trees per acre; 4, the average yield per tree was 100 pounds of fruit; and 5, the cost of the oil-wax emulsion was $2 per gallon.

Since the emulsion was used in the concentration of one gallon per 100 gallons of spray mix, and may be applied in combination with the regular fungicide, the additional cost per tree for two treatments would amount to $0.20. Bearing the foregoing assumptions in mind, the only two variables remaining are the price per pound of the fruit and the increase in the yield obtained as a result of applying the emulsion. The value for the increase in weight in the table above was arbitrarily chosen as 10 percent. There is, however, no reason to believe that this figure represents the maximum which might be obtained, but, on the other hand, it seems more nearly to approach the minimum value to be expected from two applications of the oil-wax emulsion. This statement is based upon the fact that an average increase of approximately 10 percent in the weight of cherries was obtained from the three experimental plots mentioned above in which two applications of the emulsion were made. This increase was considered quite significant in view of the fact that the rainfall for the areas in which the orchards were situated was estimated as about average.

As shown in the table above, if the market value for cherries were above $0.02 per pound the use of the emulsion sprays would result in an increased profit for the grower. If a 15-percent increase were obtained, the market value could decrease to $0.015 per pound and a net increase of $2.50 per acre would still be realized. This apparently high value for the increase in the weight has been obtained in the afore-mentioned preliminary experiments, and it is possible that under similar climatic conditions the use of the emulsion sprays may again result in such a marked increase.

Although the oil-wax emulsion sprays are undoubtedly capable of causing an increase in the size of fruit, it must be realized that other factors, such as the amount of precipitation during fruit development, tree vigor and productivity and soil practices, also play an important role. Consequently, it is impossible to predict the outcome of the use of these emulsions, and the results obtained from year to year (or from orchard to orchard) are not necessarily strictly comparable.

It is undoubtedly true that under similar conditions more benefit would be derived from applying the emulsion to heavily bearing trees than would be obtained in the case of medium- or light-bearing trees. For example, in a series of experiments with Montmorency cherry trees in which the second and third cover sprays consisted of

an oil-wax emulsion (1:100) plus a fungicide there was a 16.8-percent increase in the weight of the fruit picked from the heavily bearing trees as compared with approximately 4 and 3 percent for the medium- and light-bearing trees, respectively. The over-all increase in this experiment was about 9 percent. This value, however, does not necessarily represent the increase which would have been obtained if the entire orchard had been sprayed since the distribution of the three groups of the experimental plot was not necessarily representative of the distribution in the entire orchard. This statement is also applicable to the other field trials which were conducted and must be kept in mind during this discussion.

The application of the oil-wax emulsion sprays to trees growing on sod or on cultivated land may not produce an equivalent effect. It was observed that the over-all increase in the weight of cherries obtained from trees growing on sod and treated once with a 1-percent concentration of the emulsion amounted to about 9 percent. This value increased to approximately 13 percent after two applications of the material. In the same orchard the trees growing on cultivated land responded very little to one application of the emulsion but two applications produced fruit which was about 7.5 percent larger by weight than that of the control trees. However, in another orchard a 5-percent increase in the size of the fruit resulted from one application of the emulsion to trees growing on cultivated land. In this latter orchard the trees were not uniform with respect to productivity or size and the increase is the average of all of the trees in the test plot and would, therefore, be somewhat representative of what might be expected from the average orchard.

NO APPARENT INJURIOUS EFFECTS

No evidence has been obtained to date which would indicate that the use of the oil-wax emulsion sprays at the low concentration of 1 percent results in injury to the trees. In greenhouse experiments designed to study the effect of high temperatures on potted cherry trees which were sprayed with oil-wax emulsions of the above concentration, there was no apparent injury after the temperature had reached 100° F. or higher for at least 17 of the 39 days during which observations were made. During five of these 17 days the temperature was equal to, or greater than, 110° F. Additional tests upon plants more susceptible to injury confirmed this fact. More-

over, a group of Montmorency cherry trees which had been given two applications of a 2-percent suspension of the emulsion during the 1946 fruit growing season showed no injurious effects of the treatments.

METHOD OF APPLICATION

From the experimental evidence at hand, it appears that equivalent results may be obtained either by applying the oil-wax emulsion sprays as a separate treatment or in combination with the customary fungicide. The latter method would, of course, be more economical as it would eliminate the additional expense involved in making two extra spray applications. Since the emulsions are compatible with hard water as well as with the numerous fungicides, special spray equipment is not needed.

RECOMMENDATIONS FOR USE OF OIL-WAX EMULSIONS

Several oil-wax emulsions have been tested and have been found to give practically similar results with respect to their influence upon the size of cherries, hence, the choice of the emulsion to use is governed mainly by manufacturing problems involved in their preparation. The two products designated as Nos. 82 and 222 have been made on a commercial scale through the cooperation of the Dow Chemical Company and the Ford Motor Company. Of the two products, No. 222 is more conveniently prepared; therefore, it is believed advisable to use it for large scale applications. This emulsion may be obtained from the Dow Chemical Co., Midland, Michigan, under the trade name of Dowax 222.

In view of the results thus far obtained, it seems economically most advisable to apply the oil-wax emulsion sprays in combination with the fungicide for the second and third cover spray. The emulsion should be used at a dilution of 1 to 100 and the trees given a thorough coverage. In preparing the dilute emulsions either of the following methods may be used: first, thin the concentrated emulsion by slowly adding water while stirring until approximately two volumes of water have been added. This diluted suspension may then be added to the water and fungicide in the spray tank. The second, and the more convenient method, would be to add sufficient water to the spray tank so as to get good agitation when the agitators are

operating and then add the required amount of concentrated emulsion. After thorough mixing and while the agitators are running the remainder of the water and the fungicide may be added.

ACKNOWLEDGMENTS

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The authors wish to express their appreciation to the Dow Chemical Company and to the Ford Motor Company for their cooperation in preparing large quantities of emulsions Nos. 82 and 222; to members of the staffs of the Section of Agricultural Chemistry for their aid and to W. D. Baten, Section of Statistics, for his help with statistical analysis. Particular appreciation is due to C. G. Barr, formerly of the Department of Botany, for his cooperation with the greenhouse experiments; to Anna Kazenko for technical assistance; and to John Lyons, Neil Morrison, C. W. Duncan and Walter Toenjes through whose cooperation the field trials were made possible.

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SPRING WHEAT TESTS AT EAST LANSING, MICHIGAN, 1930-46

By HUBERT M. BROWN
SECTION OF FARM CROPS

SPRING WHEAT has not been a very satisfactory crop in the lower peninsula of Michigan as shown by the fact that comparatively few farmers in this area have grown it for more than a few years. There are various reasons for this, chief of which are lack of adaptability of many of the hard spring wheats and the desire of producers and processors alike to maintain Michigan's reputation as a source of good soft red or soft white wheat.

Experience has shown that it is inadvisable to attempt the growing of hard and soft wheats in the same district. Mixing lots of hard red winter or hard red spring with soft wheats when done under controlled conditions with known quantities of known qualities, as is done in commercial blending is a good practice, but, if such mixing is in unknown proportions, as is likely to be the case when hard and soft wheats are grown in the same neighborhood, there is a great opportunity of causing trouble at the mill and in the bakery. For that reason hard wheat, winter or spring, is not recommended for general production in the lower peninsula. To permit the use of spring wheat on the farms of this portion of the state, an attempt is being made to obtain an adapted soft red spring with acceptable flour characteristics and high yield of grain.

For those few cases where all of the grain is to be fed to livestock, it may be desirable to grow one of the higher protein, hard wheats rather than the flour acceptable soft varieties with lower protein content. If such higher protein wheat is grown, care should be taken to see that all of it is fed rather than allowed to get into the flour stream.

Contrary to the opinion of some persons, adapted varieties, if kept pure and free from disease, will not "run out". If unadapted

ARTICLE 29-26

varieties are grown, natural selections may be extensive enough in two or three years to change materially the appearance of the variety and it will look as though the variety had "run out". If mixtures, either mechanical or by natural crossing, occur, then "running out" is very likely to occur and new seed will have to be obtained.

VARIETY TRIALS AT EAST LANSING

In 1930 and 1931, two varieties of spring wheat were grown along with the other spring-sown grains on the College farm, but these two did not seem very productive under the conditions at East Lansing and were dropped. In 1937, nine strains and varieties were assembled into a spring wheat nursery. Since then 25 other strains and varieties have been included in these tests for one or more years. Table 1 gives the bushels-per-acre yields of the 15 lots on test in 1946 for each year they have been in the testing program. Those spring wheats (21 of them) which have been discarded because of low yields prior to the 1946 plantings are as follows: Baart, Ceres x Hope (C.I. 11428-10), Chinese x Emmer (1937 Row 12528, and Row 12531), Chinese x Progress (30460A3-1-1), Chinese x Webster (2667A11-37-4-3-3), Hope, Ill. No. 1-B10, Ill. No. 1-B63, Ill. No. 1-W38, Marquis, Mercury, New Hope, Premier, Progress, Regent, S.P.I. 73046-4, S.P.I. 74086, Thatcher, Washington Federation No. 1, and White Federation 38. The cause for low yields has not been the same for all

TABLE 1—*Yields of spring wheat varieties[1] and strains, grown at East Lansing, Michigan, during 1938-46, in bushels per acre.*

Year	1938	1939	1940	1941	1942	1943	1944	1945	1946	Ave.	Ave. 1944-1946
Ill. No. 1-127	16.0	18.2	34.0	14.8	23.2	24.7	25.6	28.3	34.2	24.3	29.4
Ill. No. 1-128	14.6	19.1	34.4	15.9	19.6	23.2	25.7	31.0	35.3	24.3	30.7
Sturgeon	.....	20.3	32.1	13.0	15.5	21.9	20.3	23.7	27.7	21.8	23.9
Frondosa	.....	15.4	28.5	10.7	18.5	24.3	23.7	25.8	23.2	21.3	24.2
30460A5-3-2-3	.....	.....	.....	.....	16.8	19.7	20.3	25.2	18.9	20.2	21.5
30460A5-3-5-3	.....	.....	.....	.....	13.6	22.6	22.2	23.3	21.7	20.7	22.4
S. D. 2259	.....	.....	.....	.....	.....	.....	20.1	23.0	20.9	.....	21.3
S. D. 2266	.....	.....	.....	.....	.....	.....	22.0	23.3	24.6	.....	23.3
S. D. 2280	.....	.....	.....	.....	.....	.....	19.4	20.9	21.4	.....	20.6
Henry	.....	.....	.....	.....	.....	.....	26.8	26.5	23.4	.....	25.6
H168-1-5-13	.....	.....	.....	.....	.....	.....	25.1	28.1	25.8	.....	26.3
Pilot-13	.....	.....	.....	.....	.....	.....	23.8	22.6	28.0	.....	24.8
Merit-3	.....	.....	.....	.....	.....	.....	24.9	19.2	23.2	.....	22.4
Newthatch	.....	.....	.....	.....	.....	.....	19.6	20.6	18.3	.....	19.5
Mida	.....	.....	.....	.....	.....	.....	19.3	24.5	19.8	.....	21.2

[1]The author wishes to express his thanks to the following who have graciously sent samples of spring wheat for inclusion in the East Lansing trials: Dr. R. M. Caldwell, Dr. E. R. Ausemus, Dr. B. B. Bayles, Prof. Boyd Churchill, Dr. John Grafius, Dr. B. D. Leith, Dr. R. G. Shands, Mr. Evart Vander Meulen, Dr. L. R. Waldron, Isbell Seed Co., and Voight Milling Co.

varieties. Some have been very susceptible to Hessian fly and others to the rusts. Still others were selected for the type of climate in other states and could not produce sufficient grain under Michigan's humid weather conditions to warrant their continuance.

DATE OF PLANTING

It has been stated that spring wheat is like barley or oats in that it should be planted as early as possible in the spring. Two years' evidence that this is the case is given in Table 2. It will be recalled that there was a very early spring opening in 1945, and an almost as early one in 1946. Four varieties, Ill. No. 1-127, Ill. No. 1-128, Frondosa, and Henry were planted on each of four dates in 1945. These varieties plus H168-1-5-13 and Sturgeon were planted on each of four dates in 1946. It will be noted that in either year the larger yields came from the earlier planting dates. Seasonal variations must be considered when comparing the two years. This is the probable explanation as to why the March 27, 1945, yield was lower than that of April 4, 1946.

RATE OF PLANTING

Rate of planting was studied in 1945 and 1946. In 1945 two rates (6 and 9 pecks per acre) were used on the March 27 and April 11 dates of planting. In 1946, three rates (6, 9, and 12 pecks per acre) were used on the April 4, and 22 dates of planting. The same four strains in 1945 and six strains in 1946 which were used in the date of planting test were used in this rate of planting study. The results for these two years are given in Table 3. While two years' results are not conclusive, they are probably indicative as to what

TABLE 2—*Comparative effect of date of planting upon yield of grain in bushels per acre in spring wheat tests at East Lansing, Michigan. The yields are averages of four strains in 1945 and six in 1946.*

Date	March			April			May	
	16	22	27	4	11	22	29	7
1945	34.6	32.1	27.9	.....	24.7	.....	.....	.....
1946	.....	.....	.....	28.5	.....	25.0	18.4	14.2

Table 3—*Comparative effect of rate of planting upon yield of grain in bushels per acre in spring wheat tests at East Lansing, Michigan. The yields are averages of four strains in 1945 and six in 1946.*

Date of planting	Rate of planting in pecks per acre		
	6	9	12
1945, March 27	28.9	26.9	.....
April 11	24.9	24.4	.....
1946, April 4	31.1	28.1	26.2
April 22	23.5	27.1	24.2

may be expected under similar conditions. Apparently 6 pecks per acre is adequate for the early plantings, but an increase in planting rate up to 8 or 9 pecks gave higher yields in the later plantings.

OTHER CULTURAL DATA

Seed should be thoroughly cleaned and then treated with New Improved Ceresan, or similar product, to control bunt (stinking smut).

Spring wheat has been such a minor crop that little work has been done on its fertilizer requirements. Until such data are available one will probably not go far astray by using in the upper part of the lower peninsula (above the Bay City-Muskegon line) a 4-16-4 at 200-400 pounds per acre (same as for upper peninsula). In the remaining portion of the state, a 2-16-8 or 3-12-12 fertilizer at 200-400 pounds per acre is suggested. For further suggestions, refer to "Fertilizer Recommendations," Michigan Extension Bulletin 159 under barley and oats from which the above-mentioned analyses and rates were taken.

Comparative data for spring and winter wheats grown at East Lansing for date of binder harvest and yield of grain for the period 1938-44 were given in the Quarterly Bulletin of the Michigan Agricultural Experiment Station for February 1945, Vol. 27, No. 3, pp. 320-321. The results for the last two years are similar to the previous years and give the following averages for 1938-46: spring wheat was 15 days later in ripening and produced some 13.4 bushels per acre less grain than winter wheat.

Comparative data from the East Lansing plots for the nine years, 1938-46, for barley, oats, spring wheat and winter wheat give yields

of grain in bushels per acre of 41.5,[1] 78.4, 19.7, 33.1, respectively. On the basis of pounds of grain per acre, a fairer way to make the comparison on account of the different test weights, the four grains averaged 1,993, 2,509, 1,181, and 1,985 pounds of grain per acre, respectively. The livestock feeder is concerned with total digestible nutrients. If use is made of the TDN percentages given in Morrison's *Feeds and Feeding*, the pounds per acre of total digestible nutrients for the averages above become 1,570 for barley, 1,794 for oats, 987 for spring wheat and 1,659 for winter wheat.

In these same tests the date of maturity of spring wheat has been later than that of barley and oats as well as winter wheat.

[1]Yields for barley and oats were obtained from Dr. E. E. Down and Prof. J. W. Trayer, Jr.

AIR DOGS FOR SMALL SAWMILLS*

By R. C. JOHNSON
SECTION OF FORESTRY

As PART of its research program for the improvement of small sawmills, Michigan State College, in cooperation with the Michigan State Planning Commission and the Lake States Forest Experiment Station, has developed air dogs that can be easily installed on practically any sawmill carriage except the very smallest types.

Air dogs now available from commercial manufacturers, at least those known to the College, are designed for high-production sawmills, principally of the band headrig type. The cost and design of these large dogs make them unpractical for most circular sawmills and small band mills. The objective of the research project was to develop an air dog which would be practical for these smaller sawmills. Simplicity of design, adaptability to a wide variety of headblocks and low cost were stressed. In accordance with this policy the dogs were designed as attachments to bolt to the side of the headblock knees. For most makes of carriages, four to six bolts are used to attach the air dog assembly to the side of the knee. The holes already drilled in the knees for the Knight type of post dog can be used to attach the air dogs. The dogs pictured in this article were designed for medium-to-large size circular mill carriages and for small band mill carriages. By reducing cylinder diameter and the size of iron used in fabrication the same design could be adapted to still lighter headblocks.

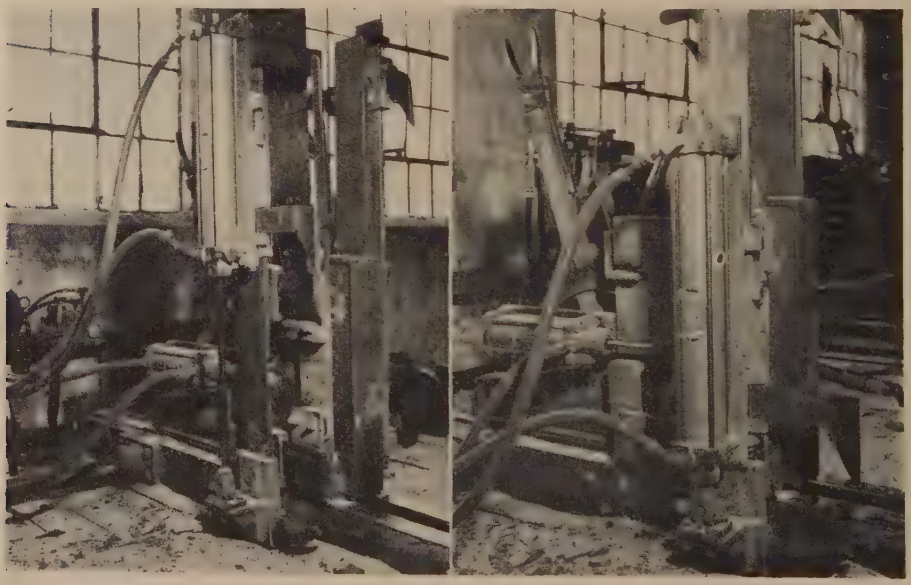
A test installation was made in October of 1946 at the L. L. Johnson Lumber Company sawmill at Charlotte, Michigan. The Johnson mill is a six-foot band mill with a three-headblock carriage with twin-engine steam feed. An edger, end trimmer and slab saw

*This report is one of a series issued, or to be issued, in conjunction with a wood research project designated as "Improvement of Small Sawmills". This project has been undertaken by Michigan State College at the request of the Forest Products Research Committee of the Michigan State Planning Commission, which has initiated, and, through a legislative grant of $25,000, is financing in part or in whole, several such research projects. Substantial contributions to the Small Sawmill Improvement Project have also been made by the Lake States Forest Experiment Station and by Michigan State College.

ARTICLE 29-27

complete the equipment. Daily production runs from 10 to 15 thousand board feet of mostly 4/4 hardwood lumber. The dogs have been in continuous operation for two months without failure or repair except for freezing of condensation in the traps. This was overcome by installing an extra lubricator to inject a small quantity of alcohol into the air system. The test is being continued to determine how the dogs will stand up in long time service. The principal features in design include the following:

Two double-acting air cylinders are used for each headblock. The vertical cylinder has a 3-inch bore and a 19-inch stroke. The cylinder is attached to a slide which carries the top dog. The end of the piston rod is attached to an under dog which is also mounted on a slide. As the piston rod is extended it forces the dogs apart a maximum of 22 inches. When air is reversed to the other end of the cylinder the dogs close on the log or cant to a minimum of 3 inches. Since the bottom dog is slide-mounted it will grip any log regardless of contour. For large logs, where a 22-inch opening is not sufficient, the top dog can be shifted 10 inches up on the top slide to a



A B

Fig. 1. Detail views of air dog post assembly. In A the dogs are opened to the maximum. The whole dog post is pulled back in position for dogging the last board. In B the dogs are closed and the dog post is pushed forward with the dog points 7 inches beyond the face of the knee.

Fig. 2. An over-all view of the air dog installation at the L. L. Johnson Lumber Company. Note the convenient location of the air valves for the setter. Note also the heavy iron stop just below the end of the cant which keeps the underdog from getting into the saw line.

higher dog position. Quick release pins facilitate rapid manual shifting of the top dog. In the top position the dog opening is 32 inches. The quick release pin for the upper dog position is not shown in the illustrations. For mills consistently sawing large logs a longer cylinder should be used.

The horizontal cylinder has a 3-inch bore and a 7-inch stroke. It moves the whole dog post on two horizontal slides. The cylinder is mounted rigidly on a bracket and the piston rod is attached to the dog post. When the rod is extended the whole dog post is shifted forward. The ends of the dogs extend a maximum of 7 inches past the face of the knee to dog round logs. After the log is squared the cylinder pulls the dog post back so the ends of the dogs are three-quarters of an inch from the face of the knee to permit sawing down

to a last inch board. This distance can be adjusted to fit the needs of the sawmill operator.

In addition to moving the dog post to the position just described, the horizontal cylinder can be used to pull the log or cant back against the knees after dogging to help overcome the effects of "spring" in the log during sawing. When the dog post is pulled all the way back to dog in the last board there can be no further pull back action to straighten up a springy cant. To overcome this deficiency truck valve springs were installed on the horizontal piston rod. When the dog post is brought all the way back the springs are completely compressed. The control valve for the horizontal cylinders is then put in neutral position where air neither enters or escapes from either end of the cylinder. A small bleeder valve in the air line to the head (piston rod) end of the cylinder is then briefly opened to allow the air to bleed out of the head end of the cylinder. The spring plus the air in the opposite end of the cylinder forces the dog post out about

Fig. 3. The dogs working on a round log. The hand dogs were left on opposite sides of the knees for emergency use during the testing period.

three-fourths inch, which brings the dog points about 1½ inches from the face of the knee. After dogging the cant, the horizontal cylinder control valve is set to pull the cant back. If this feature is used the sawyer ends up with 8/4 on the carriage, or he can redog with the dogs all the way back before making the last cut to end up with an inch board on the carriage. Both cylinders have air cushions for the last inch of travel to prevent shock.

Only two four-way valves are used for control. After the air lines leave the control valves they branch off to each of the headblocks so that all headblock assemblies work in unison. The bleeder valve previously mentioned is installed immediately after the control valve for the horizontal cylinder before the lines branch to the headblocks. The valve control panel can be located anywhere on the carriage.

The dog posts, slides and mounting brackets are made from standard sizes of flat iron all electrically welded. No special castings or machine work are needed to make the dogs.

A 9.8-cubic foot air compressor is mounted stationary near the band headrig and is belted to a line shaft. It is run about half the rated speed and still furnishes more than enough air. The air is transferred to the carriage through an air hose attached to the pipe air line near the mill ceiling at the approximate mid-point of carriage travel. The hose is kept out of the setter's way by means of a rope and weights to take up slack in the air line. A 10-gallon storage tank mounted on the carriage is the only storage used. It carries about 125 pounds of air. Excess air above this pressure is released through a pop-off valve. From the tank the air passes through a filter trap, then through a reducer and lubricator. A half-inch air hose going under the setter's platform brings the air to the control valves. From the valves, four air hoses drop back under the carriage and branch to each headblock. The use of air hose simplified installation of the lines under the carriage which helped to keep work areas clear of obstructions.

In tests it was found that a reducer setting to 55 pounds gives sufficient dogging power. Higher pressures speed up the cylinders but cause some defacing from deep dog marks.

No time studies have been made as yet on the Johnson installation, but observations indicate that production of lumber can be increased an estimated 5 to 10 percent over hand dogging with the

same crew. The greatest advantages appear to be: First, in materially reducing the setter's work on the carriage which makes for a more satisfied workman; secondly, better dogging with resultant better grade of lumber; and third, improved safety. It is reasonable to expect that the dogs will substantially increase production on mills where the sawyer does the setting and dogging.

Blueprint drawings of the air dogs are being prepared and soon will be available from the Department of Forestry, Michigan State College, for a nominal fee.

EGG PRODUCTION AND MEAT TYPE COMPATIBILITY

*By EARL W. HENDERSON**
SECTION OF POULTRY HUSBANDRY

SIX YEARS AGO a title for a report like the one above might not have been accepted because of general beliefs to the contrary. With considerable skepticism, a project was started at the Michigan Agricultural Experiment Station in 1940. The project was designed to determine to what extent it might be possible to combine good egg production and superior meat type in the same breed or combination of breeds.

The breed chosen was the Dark Cornish because excellent meat type has been well established in this breed since 1893, and because it has other interesting genetic characteristics. Whatever the egg-producing capabilities of the Cornish breed may prove to be in the future, for the present at least, individuals of this breed are not featured among winners of egg-laying contests. One may speculate that the reason for the lack of egg-laying reputation of the Cornish is that most breeders of this variety have concentrated primarily on "fixing" meat type. It seems probable, also, that there may have been good laying individuals of the breed which escaped recognition because they were not trapnested in official contests.

It is the purpose of this paper to record the results of the application of established breeding methods for increasing egg production in a so-called meat-type breed—the Dark Cornish. Because of the relatively small number of birds involved no conclusions regarding the breed in general should be drawn.

FOUNDATION FLOCK

The foundation flock or parental generation of the present strain of Dark Cornish consisted of 11 surviving unpedigreed pullets hatched in 1941. The females completed their records in the summer of 1942.

*Research Associate J. A. Davidson assisted in feeding and management of the flock.

ARTICLE 29-28

In 1942 they were mated to an unpedigreed male, No. 7564. For the second generation, three unpedigreed males were purchased from the University of Illinois in 1942. From that time on no new "blood" has been added to the flock, although it might have been advantageous to try out more blood lines.

PERFORMANCE OF GENERATIONS SINCE 1941

The performance of the various generations is presented in terms of total number of eggs per hen in 12 consecutive months and by average egg weight. It is recognized that total eggs per hen per year is not a very good genetic criterion, but it is a popular measure in wide general use.

Parental Generation

The number of eggs per hen the first year, 1941-42, was not promising. The best record was 160 eggs* and the records ranged downward to zero. The birds were hatched late and didn't begin laying until January 1 and showed a tendency to lay on the floor. For that reason the first year's average is not considered significant enough to publish.

First Generation, 1942-43

The first generation consisted of 78 pullets of which 17 were kept long enough to complete a 12-month record. The others were culled for various reasons and some died, of course. Broodiness—one or more times—was very general and a few were culled for that reason. The egg production of the 17 surviving pullets, was as follows: 163, 153, 151, 142, 142, 142, 138, 135, 134, 130, 114, 108, 103, 98, 93, 89, 80.

The average is 124, but it is not indicative of the entire flock because a number of poor layers were eliminated at various times. Breeders of most of the well known breeds probably would have eliminated all of the birds because 200 eggs per hen per year is the minimum standard for R.O.P. flocks. A few of the pullets exhibited good intensity which was about the only encouraging characteristic.

*A daughter of this pullet laid 243 eggs in 1946.

Second Generation, 1943-44

The second generation consisted of 158 pullets. The detailed records and average are not important and they are omitted. A few of the outstanding records of survivors were (Y 97) 206, (Y 1) 173, (Y 4) 166, and (Y 40) 157. The latter record was made the first 7 months of the laying year. The most interesting performance is that of a pullet which is designated Y 97. She made the first 200-egg record for this breed at this station. All four of the previously mentioned pullets are half or full sisters of Y 97.

Third Generation, 1944-45

The third generation consisted of 100 pullets. The best record, 180 eggs, was made by a daughter of Y 97 (the 206-egg hen of the second generation). Records of 167, and 162 were made by two other daughters of Y 97. The rest of the records were no better than those of the first generation.

Fourth Generation, 1945-46

One hundred pullets were started of the fourth generation, and the laying year is complete for most of them. The outstanding records to date are as follows: 243, 232, 222, 217, 213, 210, 209, 203, 203, 200. Such records of course are not remarkable for such other breeds as the Single Comb White Leghorn, Barred Rock, Rhode Island Red, and many others, but they do demonstrate what records are possible from birds which are also extremely good meat type. The meat type scores* for the above-mentioned pullets were as follows: 1.5, 2.5, 2.0, 2.5, 2.0, 1.5, 1.0, 2.0, 1.0 and 1.0 respectively. The system of scoring is explained by Henderson (1).

BREEDING METHODS USED TO IMPROVE EGG PRODUCTION

The breeding methods used to improve the egg production of the Cornish flock at this station are not secret. In general, they are the same as recommended by Henderson and Card (2). Progress may be more rapid if facilities to rear and maintain larger members

*Perfect score = 1. See Henderson (1).

of progeny are available. It will be recognized by most poultry breeders that the years 1941 to 1946 provided other such handicaps as feed shortages, personnel changes, and uncertainties which may have accounted for relatively slow progress.

Although the dark variety of Cornish was selected for the experiments reported herewith for genetic reasons, it is recognized that a dark-colored fowl may be handicapped for market reasons. From the results of the experiments with Dark Cornish it seems logical that progress might be just as rapid with lighter colored varieties of Cornish.

PERFORMANCE WITH RESPECT TO EGG WEIGHT

Egg weight is a criterion of well recognized importance. The Dark Cornish as a breed, in general, has not enjoyed the best of reputations with respect to weight of eggs. The characteristic of small egg size, as measured by weight, like low egg production, may vary widely within the breed, as indicated in Tables 1 and 2.

Samples of egg weight were obtained for nine pullets of the foundation flock. The weights are given to the nearest gram. (28.3 grams C = 1 oz. approximately.)

In Table 1 the average weight of all the eggs weighed is indicated. An attempt was made to obtain a sample of from three to ten eggs each month for computation of the average. The average egg weight per pullet per month is indicated in Table 2. Both tables are offered to demonstrate that the method for computing averages

TABLE 1—*Egg weights of foundation stock or parental generation, in grams.*

Pullet No.	Number eggs weighed	Average egg weight	Average of nine averages
1	38	48.3	
2	11	41.4	
3	12	53.2	
4	33	46.0	
5	30	48.3	
6	23	52.0	
7	34	45.4	
8	24	56.0	
9	29	46.0	
9	230	51.3	48.5

TABLE 2—*Average weight of eggs from Dark Cornish pullets by months in grams.*

	Jan.	Feb	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
1	47	46	50	50	51	53	54	.....	.....	.....	.....	.....	50
2	41	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	41
3	50	.....	55	53	.....	.....	.....	.....	.....	.....	.....	.....	53
4	44	46	46	46	49	.....	.....	.....	.....	.....	.....	.....	46
5	48	47	.....	.....	52	47	.....	.....	.....	51	.....	.....	49
6	53	51	.....	53	50	.....	.....	.....	.....	.....	.....	.....	52
7	44	44	46	47	50	51	50	.....	.....	.....	.....	.....	47
8	.....	55	56	56	.....	56	58	.....	.....	.....	.....	.....	56
9	45	44	.....	.....	47	49	.....	.....	.....	.....	.....	.....	46
Average	46	47	51	51	50	51	54	.....	.....	51	.....	.....	(50) *49

*Discrepancy caused by rounding off of averages.

is important. A false impression of the inherent ability of individuals may be obtained unless the method of computing averages is shown. It has been shown by Henderson (3 and 4) and many others that the weight of eggs from Leghorn pullets increases in weight from the time the first egg is laid until the end of the first laying year. A similar increase in egg weight of the Cornish is evident in Table 2. At least two methods of computing averages will be illustrated by the means of weights of pullet No. 1. An average of 38 total egg weights is 48.3 (Table 1). The average of seven monthly averages indicated in Table 2 equals 50 (rounded to the nearest gram).

The average weight of eggs during the first laying year may be useful for some purposes, but it may not be relied upon exclusively for genetic purposes. The performance of pullet No. 1 in detail should illustrate how individual variation may occur. Her average egg weight the first week of January is 47 grams. Her average from January to July is 48 grams, and the average of seven monthly averages is 50 grams. Her average for the month of July is 54 grams. The greatest average she attained in any one month the first year should be a better index of her inherent ability than the yearly average. Pullet No. 1 was alive at this writing. Her average for one month in 1943 is 61 grams. The average egg weight of pullet No. 7 in 1942 is 45 grams. The largest egg she laid in the fall of 1942 weighed only 52 grams. She was alive in 1945. She laid eggs which weighed 55 grams in 1942-43. Pullet No. 8 laid the largest eggs of the group at the outset. The first egg from Pullet No. 8 weighed 55.6 grams the 22nd of February. Her last egg weighed 59 grams. The average egg weight of pullet No. 4 is probably the

most representative of the low weight group the first year, but the average of pullet No. 7, which was nearly the same as that of pullet No. 4, is 55 grams for a sample of 9 eggs laid from December 1942, through June 1943. The smallest eggs of any of the birds retained for experimental breeding purposes are those of No. Y 97. Her maximum egg weight of 48 grams was attained in October 1944, and again in 1944-45. It is expected that her performance will be very useful in studying the mode of inheritance of egg weight. A more detailed analysis of egg weight of the Dark Cornish strain is planned for the near future, but from the data examined to date one is inclined to the tentative conclusion that the weights presented in Tables 1 and 2 represent normal expectancy for the strain.

SUMMARY

The egg-laying ability of four generations of an extremely good meat type breed of chicken (the Dark Cornish) was measured. The application of establishing breeding methods resulted in increasing production from a maximum of 160 eggs the first generation to 243 eggs the fourth generation. Ten percent of the fourth generation laid more than 200 eggs. Egg weight of the parental generation ranged from 46 grams to 56 grams.

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INFLUENCE OF SEPARATOR CLEANLINESS AND TEMPERATURE OF CREAM STORAGE ON CREAM QUALITY*

By J. M. JENSEN and A. L. BORTREE
SECTIONS OF DAIRY HUSBANDRY AND BACTERIOLOGY

FARM-SEPARATED CREAM has presented a major quality problem for creameries throughout the United States for the past half century. Previously, milk was skimmed for factory buttermaking in skimming stations or directly in creameries, and the farmer was returned the skimmilk for feeding purposes. Under that procurement system, milk had to be delivered sweet and fresh, and the control of quality was in the hands of the creamery operator. The farm separator made possible the saving of daily hauling of milk and skimmilk to and from the creamery, changed creamery practices, and resulted in "farming out" quality control to each producer. It was undoubtedly hoped that farmers would bring sweet cream to the creamery and genuine effort was made to encourage that practice. However, the result was a general deterioration in cream quality that obstructs demand for butter and aggravates officials charged with control of food sanitation standards.

Demands are placed on the creamery industry to improve cream production practices. Although this is largely a producer problem the creamery is held responsible for the quality of cream purchased. Therefore, creameries have been compelled to enforce their demands on producers to the extent that only cream of clean and sanitary quality is purchased.

That sweet cream makes the finest quality butter is fully appreciated by the creamery industry, as is also the fact that as a rule the more sour cream becomes the poorer is the quality of butter. Furthermore, certain savings are made by the creamery when sweet or low-acid cream is used. For example, a minimum amount of neutralizer

*This study was made possible through a grant from Swift & Company, Chicago, for research in milk and cream.

ARTICLE 29-29

is needed, deterioration of equipment from the action of acid in cream is reduced, and time is saved in processing.

In cream as in milk production, good keeping quality is a result of cleanliness and cooling. Milk, however, is marketed daily while cream may be held for 3 to 4 days before delivery to the creamery or cream station. Hence, conditions of storage become increasingly important in arresting spoilage.

As a means of finding a practical approach to cream of good quality, a study was made to determine the effect of storage temperature and cleanliness of separator bowls on acidity development and flavor score. The results showed substantial improvement in cream separated through a clean separator bowl over that from unwashed bowls when the cream was held at low temperatures. The factor of cleanliness was least apparent when the cream was stored at 73° F. and most noticeable when stored at 53° F.

High temperature of cream storage was the most significant factor in quality deterioration of cream. Low storage temperature resulted in highest quality cream regardless of initial contamination, and lowest quality cream resulted from highest storage temperature with evidence of improvement as affected by using a clean separator bowl versus a dirty bowl.

EXPERIMENTAL

The first part of the experiment involved determination of influence of cleanliness and storage temperature on lots of cream from the same milk supply. Ten gallons of raw, uniformly blended milk was skimmed through each of three separator bowls. Two bowls were left unwashed 16 hours previously after separating 5 gallons of raw milk of like quality through each bowl, followed by rinsing with 1 quart of tepid water to flush cream out of bowl and spouts. One of these bowls was stored at 53° F. and the other at 73° F.

The third bowl used was clean, having been immediately washed and thoroughly scalded before use. Each lot of cream was standardized to 35-percent fat with skimmilk from the clean separator bowl. One hundred milliliters of cream from each lot was transferred to each of 12 four-ounce jars. After numbering for identification, four jars from each lot were placed in each of three temperature-regulated cabinets controlled at 53°, 63°, and 73° F. One sample jar from each temperature was removed at consecutive 24-hour holding periods

for acid determination and flavor scoring based on flavor defects anticipated in butter that would normally be made from such cream. Acidity tests were made by weighing 9-gram samples of well mixed cream and titrating with n/10 sodium hydroxide.

Flavor scores were determined by two experienced dairy products judges, with the samples arranged to obscure their identity. Standard plate bacteria counts were made on each lot of freshly separated cream. Eight trials were similarly conducted.

The temperatures 53 , 63 , and 73 F. for cream storage were selected as representative of storage conditions encountered under Michigan conditions where fresh, well water temperatures usually are found to be at 53 F. and under; while air storage temperatures, as indicated by the cream temperature, received in creameries, usually range between 63° and 73° F.

INFLUENCE OF SEPARATOR BOWL CONTAMINATION ON CREAM QUALITY

The influence of the degree of cleanliness of the separator bowl on quality of cream was apparent, as measured by (1) bacteria count of freshly separated cream, and (2) by acidity development and appearance of the cream, as well as (3) by taste and odor observed in grading.

Average bacteria counts made on freshly separated cream were 41,000 when separated through a freshly cleaned and sanitized bowl, 90,000 when separated through a bowl that had been used 16 hours

TABLE 1—*Average percentage acidity of cream samples stored at 53°, 63°, and 73° F. when skimmed through a clean separator bowl and two unwashed bowls held 16 hours at 53° or 73° F.*

Temperature of cream storage	Condition of separator bowl	Percentage acidity after				
		0 hours	24 hours	48 hours	72 hours	96 hours
53° F.	Clean	0.12	0.141	0.171	0.224	0.33
	Unwashed 53° F.	0.12	0.146	0.202	0.303	0.382
	Unwashed 73° F.	0.12	0.155	0.265	0.340	0.454
63° F.	Clean	0.12	0.195	0.40	0.56	0.645
	Unwashed 53° F.	0.12	0.246	0.481	0.62	0.665
	Unwashed 73° F.	0.12	0.318	0.51	0.633	0.672
73° F.	Clean	0.12	0.287	0.52	0.66	0.71
	Unwashed 53° F.	0.12	0.374	0.58	0.674	0.70
	Unwashed 73° F.	0.12	0.434	0.624	0.70	0.72

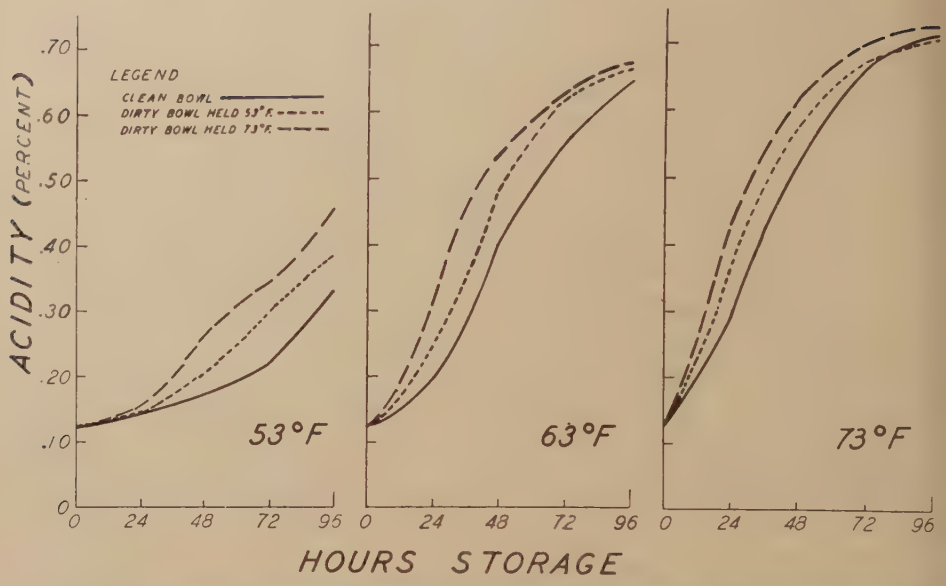


Fig. 1. Showing increase in acidity of cream from clean and from unwashed separator bowls held at 53° and 73° F. respectively, while storing cream at 53°, 63°, and 73° F.

previously and which had been stored between use at 53° F., and 241,000 in cream separated through an unwashed bowl stored at 73° F.

Although these bacteria counts were not extremely high, even when cream was separated with the most highly contaminated bowl, there was sufficient difference in the degree of contamination to influence materially the rate of acid development, as shown in Fig. 1 and Table 1, at 53°, 63°, and 73° F. storage. Greatest benefit from cleanliness of the separator bowl was secured at the lower cream storage temperatures.

QUALITY OF CREAM AS MEASURED BY GRADING

The quality of cream as measured by grading is presented in Table 2. Under each storage temperature the flavor score was generally highest when clean separator bowls were used and lowest when separator bowls had been stored at 73° F. 16 hours without washing after use. Flavor scores of 92 were maintained in cream for 72 hours of storage at 53° F. when clean separators were used, while with both unwashed bowls 92 score cream was maintained

TABLE 2—*Average score of cream samples stored at 53°, 63°, and 73° F. when skimmed through a clean separator bowl and two unwashed bowls held 16 hours at 53° or 73° F.*

Temperature of cream storage	Condition of separator bowl	Score of cream after				
		0 hours	24 hours	48 hours	72 hours	96 hours
53° F.	Clean	93	93	92.6	92	91.4
	Unwashed 53° F.	93	92.5	92.3	91.6	91
	Unwashed 73° F.	93	92.6	92	91.5	90.9
63° F.	Clean	93	92.2	90.7	90.3	89.4
	Unwashed 53° F.	93	91.6	90	89.7	89.8
	Unwashed 73° F.	93	91.6	89.9	89.6	88.9
73° F.	Clean	93	91.3	89.9	89.4	88.8
	Unwashed 53° F.	93	90.8	89.9	89.6	88.8
	Unwashed 73° F.	93	90.5	89.9	89	88.2

only 48 hours. When cream was stored at 63° F., clean separator cream had an average score of 90.3 after 72 hours, while 90 score cream was maintained only 48 hours with both unwashed separators. At 73° F. storage a score of 90 was retained only 24 hours in cream samples from the unwashed bowl held at 73° F.

Second grade cream is generally considered to be of a quality which causes the butter to be scored lower than 89. Such scores were largely found in cream stored at 73° F. for 96 hours, but predominated in cream from unwashed bowls held at 73° F.

INFLUENCE OF STORAGE TIME AND TEMPERATURE ON CREAM QUALITY

As shown by Table 1 and Fig. 1, the temperature at which cream was stored had a major effect on acid development. Low storage temperature resulted in low acidity development, and high storage temperature in high acidity. This is further shown in Fig. 2 which presents average cream acidities at 24-hour intervals in samples from clean, dirty at 53°, and dirty at 73° F. bowls, stored at 53°, 63°, and 73° F. These results emphasize the need of cooling to lower temperatures than are generally provided under atmospheric conditions in order to reduce bacterial development and cream spoilage.

Essentially as much acidity was developed in cream stored 24 hours at 73° F. as in cream stored 96 hours at 53° F. Also the score of cream (Table 2) was slightly higher when held 96 hours at 53° F. than when held 24 hours at 73° F. In general, deterioration was

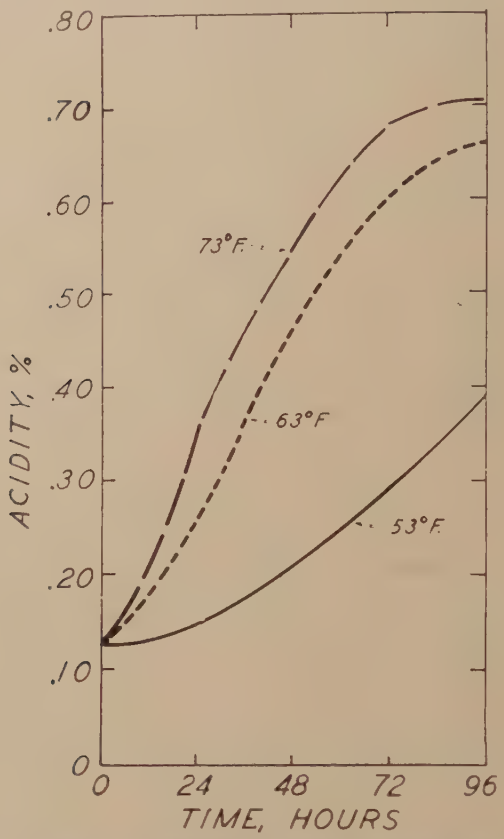
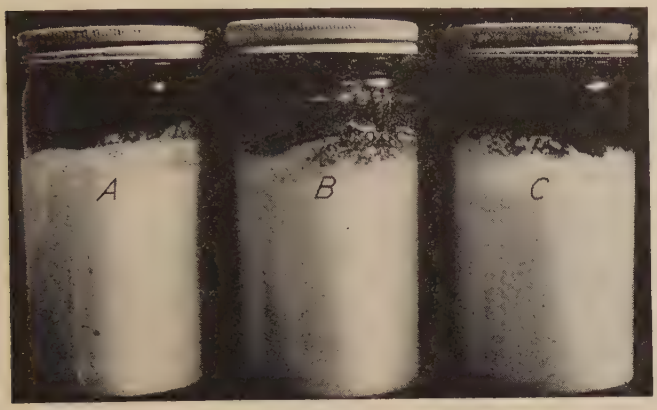


Fig. 2. Showing average increase in acidity of cream stored at 53°, 63°, and 73° F. from clean and from unwashed separator bowls held at 53° and 73° F.

influenced to a greater extent by temperature of cream storage than by factors of cleanliness of bowls and time of storage when cream was held 4 days.

DISCUSSION OF RESULTS

These results on cream deterioration, though limited in number, emphasize the importance of clean separators, cooling to lower-than-normal atmospheric temperatures, and need of frequent delivery. Deterioration in quality due to contamination in unclean separator bowls stored at 53° and 73° F. was not so marked as had been anticipated. The separators used were in excellent condition and showed no loss of tinning. Thus, it is possible that if poorly tinned separator disks had been used results would have been less favorable.



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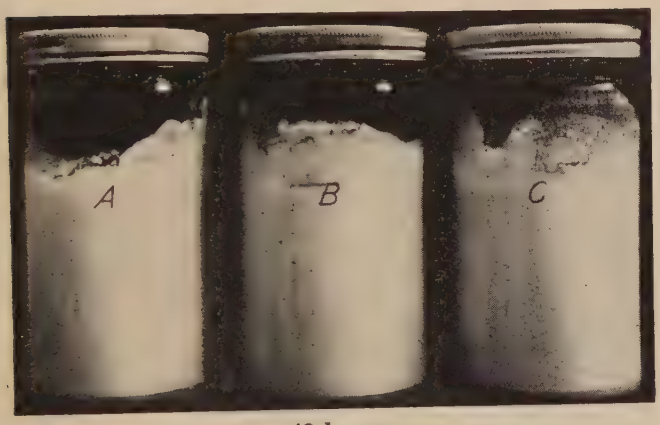
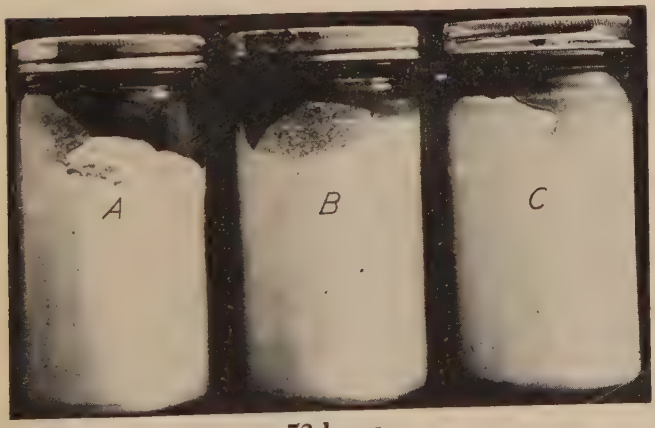
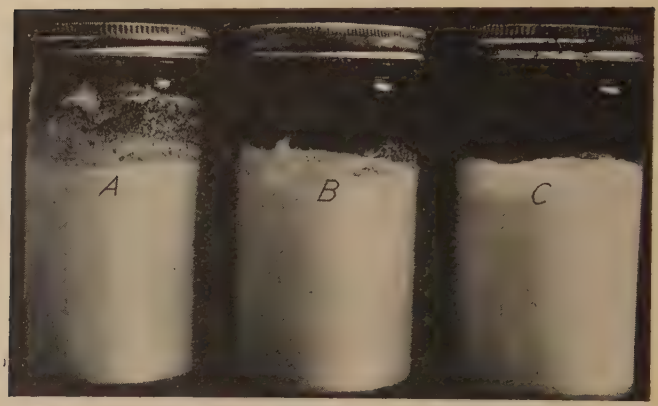


48 hours



72 hours

Fig. 3. Showing typical appearance of cream samples from clean (A) and from unwashed separator bowls held at 53° (B) and 73° F. (C) respectively, when cream was stored at 53° F.



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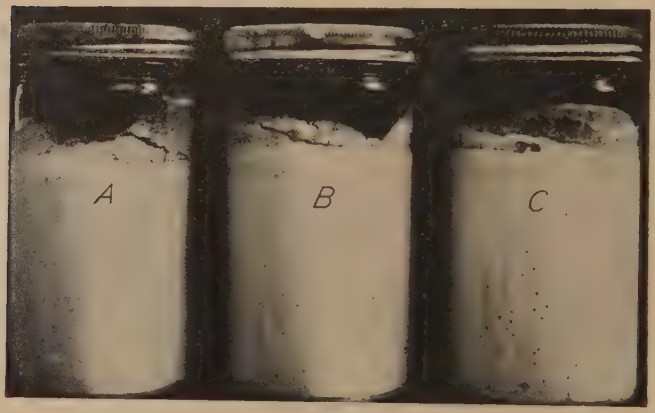

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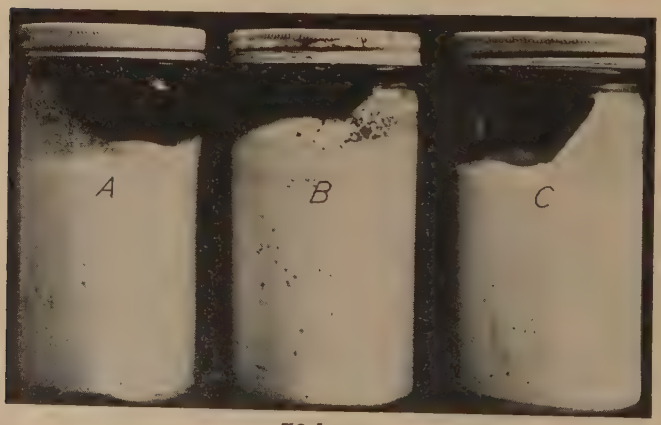
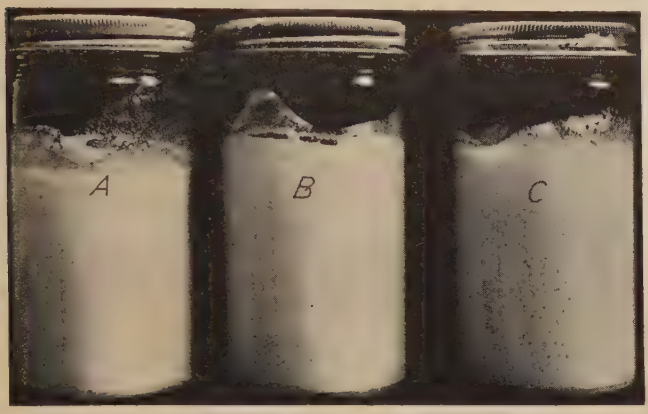
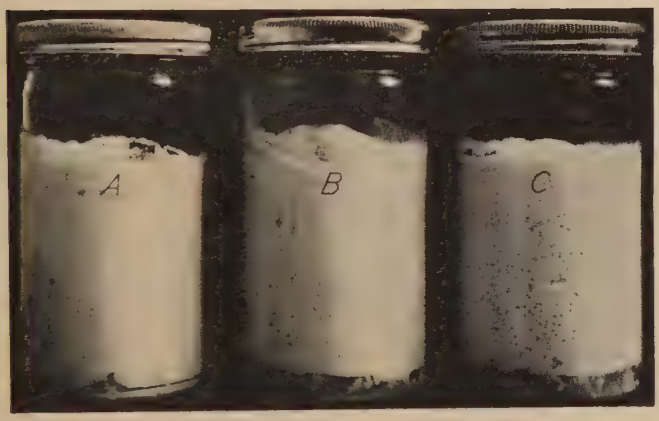


72 hours

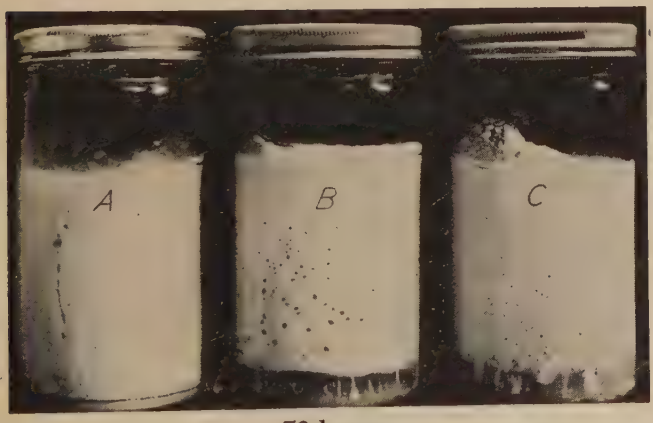
Fig. 4. Showing typical appearance of cream samples from clean (A) and from unwashed separator bowls held at 53° (B) and 73° F. (C) respectively, when cream was stored at 63° F.



24 hours



48 hours



72 hours

Fig. 5. Showing typical appearance of cream samples from clean (A) and from unwashed separator bowls held at 53° (B) and 73° F. (C) respectively, when cream was stored at 73° F.

Temperature of storing cream was the most significant factor in controlling cream quality. This was shown by the higher quality cream produced at 53° storage, as compared with that kept in storage temperatures of 63 and 73 F. Cream of good quality deteriorated rapidly at temperature conditions suitable for bacterial growth. This spoilage became especially acute when cream was held for 3 to 4 days. It would seem, therefore, that in production of farm-separated cream, cooling to approximately 53 F. or lower is of extreme importance.

Although temperatures of 63 and 73 F. are in a range suitable to the growth of lactose fermenting bacteria, at no time did fermentation develop at those temperatures without the curd becoming gassy (Figs. 3, 4, and 5). The gassiness in the curd seemed to be associated with old cream flavor that developed as early as 24 hours of storing at 73° F.

The findings in this study agree with previously reported findings of Wilster, Hoffman, and Brandt (1), who found that the most satisfactory means of maintaining the quality of Oregon farm-produced cream was accomplished by storing in water ranging in temperature from 47° to 54° F. They also agree with findings of Johns (2), who reported that the temperature at which an unwashed separator bowl is held materially influences bacterial contamination.

It could be concluded that although cleanliness of utensils—particularly the cream separator—is of serious importance, these contaminants would seem comparatively insignificant when considering the gross contamination resulting from adding freshly separated cream to a lot of cream already in a high degree of fermentation because of high storage temperature. By that it is not intended that cleanliness should not be emphasized or insisted upon, but it should be understood that quality cream cannot be produced by keeping dairy utensils clean unless low cooling temperatures are maintained.

STOREABILITY OF CREAM IN HOUSEHOLD REFRIGERATOR

As a supplement to the study presented, 12 trials were made to determine the quality of cream that could be produced by storing cream in closed containers in a mechanically refrigerated household refrigerator. For this experiment, especially built square-type cans

with rounded corners were used as a means of conserving space in the refrigerator. The experimental cans were made of tinned copper to hold 2½ gallons of cream. They were provided with flat top covers constructed with an inner lip to prevent odor contamination from the refrigerator. A small handle was fixed on the side of each can for convenience in removing the cans from the refrigerators (Fig. 6).

In six trials freshly separated raw cream, skimmed from morning milk, was chosen from the milk supply of the Michigan State College Creamery. This cream was separated directly into the storage cans and placed in the refrigerator without pre-cooling.

Fig. 6. Square-type cream cooling cans, equipped with covers, for household refrigerator cream storage.

In six further trials similarly obtained cream was used, and 4 pounds of cream was transferred to storage cans at 24-hour intervals. These lots were pre-cooled in cold water to 60° F. before blending with the previously cooled lots.

Cream from both trials was examined for acidity and flavor fresh and after 24-, 48-, 72-, and 96-hour storage periods.

Results are shown in Tables 3 and 4. Data in both tables show that excellent control can be maintained over acidity development at 40° F. storage, such as is generally maintained in household mechanical refrigerators. Excellent flavors were likewise maintained in the cream, but gave indication of tending toward metallic flavors on 4-day storage. It was thought likely that the tinned copper containers were largely responsible for this flavor development since tin

TABLE 3—*Storeability of cream in household refrigerator at 40° F.*

Trial	Storeability of raw cream as measured by									
	Percentage acidity of cream after					Flavor score of cream after				
	0 hours	24 hours	48 hours	72 hours	96 hours	0 hours	24 hours	48 hours	72 hours	96 hours
1	0.12	0.12	0.13	0.14	0.16	93	93	93	93	92
2	0.125	0.13	0.13	0.15	0.18	93	93	93	93	92
3	0.12	0.13	0.13	0.13	0.14	93	93	93	93	92*
4	0.115	0.12	0.12	0.13	0.13	93	93	93	92	90**
5	0.115	0.115	0.12	0.12	0.125	93	93	93	93	93
6	0.12	0.125	0.14	0.15	0.17	93	93	93	93	92*

*Flavors were criticized for being slightly flat.
**Flavors were criticized for being slightly metallic.

TABLE 4—*Storeability of cream at 40° F. in household refrigerator when 4-pound increments were added daily.*

Trial	Storeability of cream at 40° F. when accumulating daily additions as measured by									
	Percentage acidity of cream after					Flavor score of cream after				
	0 hours	24 hours	48 hours	72 hours	96 hours	0 hours	24 hours	48 hours	72 hours	96 hours
1	0.12	0.125	0.13	0.13	0.13	93	93	93	93	92*
2	0.12	0.125	0.13	0.135	0.145	93	93	93	93	92*
3	0.11	0.12	0.13	0.13	0.13	93	93	93	93	92*
4	0.11	0.13	0.135	0.135	0.135	93	93	93	93	92*
5	0.12	0.13	0.13	0.135	0.13	93	93	93	92	90*
6	0.12	0.13	0.13	0.13	0.13	93	93	93	92	90**

*Flavors were criticized for being slightly flat.
**Flavors were criticized for being slightly metallic.

is known to be porous, and it is also generally known that copper salts are active catalysts in promoting metallic flavors.

Spun aluminum cans or stainless steel cans would undoubtedly be superior receptacles for cream storage.

The general concept that cream deteriorates rapidly after the third day of production seems to hold in handling sweet raw cream as well as sour cream. In both series of trials the flavor score, with one exception, was lowered one to two points in all trials.

There was no perceptible difference in quality as measured by grading when one lot was stored in a can during the regular storage period as shown in Table 3, when compared with storage of daily additions of fresh cream as shown in Table 4. Also, there was little if any perceptible difference in acidity development.

The factors that affect the deterioration of cream for butter-making were re-evaluated in this study. The three essential factors in successful maintenance of good cream quality are time, temperature, and contamination. These three factors are usually given equal weight by sanitarians, and the results of this study coincide with this concept. Much attention is given to washing of separators, and the obstacle to cleaning has been overcome by flush washing procedures employing special detergents. Similar attention should be directed in cooling and frequent delivery of cream or the affect of better sanitation compliance will not result in the quality improvement that is desired.

Facilities such as fresh, cold running water at approximately 53° F. or mechanical refrigeration should be available simultaneously with clean separators in producing cream of good quality.

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MODIFICATION OF THE PHYSIOLOGICAL ACTION OF THE SODIUM SALT OF 2, 4-DICHLOROPHENOXYACETIC ACID BY SIMULTANEOUS APPLICATION OF PLANT EXTRACTS AND BY pH CHANGES*

By E. H. LUCAS and C. L. HAMNER
SECTION OF HORTICULTURE

THE HERBICIDAL ACTION of 2, 4-dichlorophenoxyacetic acid and its derivatives has been recognized as being physiological in character. The normal growth processes are thrown out of balance and reactions take place within the plant which eventually lead to its death. It may be assumed that these substances either catalyze reactions which do not normally occur in plant cells, or that they interfere with physiological functions of the plants by combining with substances essential in such functions. All plants do not respond uniformly to the action of 2, 4-dichlorophenoxyacetic acid. Monocotyledonous plants, notably the grasses, are relatively resistant.

The present paper is a preliminary report of rather striking observations which were made during experiments conducted with the original aim of chemical inactivation of 2, 4-dichlorophenoxyacetic acid and its derivatives. Earlier unpublished studies had indicated that some relationship existed between antibacterial substances derived from onion and garlic, and growth-regulating chemicals. The nature of these studies necessitated the application of time-consuming procedures, and their progress consequently has been slow. However, a certain phase of this work led to the observations mentioned which, when followed up, quickly yielded reproducible results.

EXPERIMENTAL

Aqueous extracts of the Michigan Sweet Spanish onion were used in the experiments to be described. The onions had been stored for

*This study was made possible in part by funds provided by the Rackham Research Endowment.

ARTICLE 29-30

approximately 2 months at 6-8 C. Healthy, medium-sized bulbs were macerated in Waring Blendors with varying amounts of distilled water. The macerates where filtered through cheesecloth in most instances, but occasionally coarse fluted paper was used. In these cases use was made of Celite No. 503 (Johns-Manville) to facilitate filtration. The ratio between plant material and water was given careful attention; this proved to be of decisive importance, as will be pointed out later.

The extracts thus obtained were mostly used as the solvents of a preparation of the Dow Chemical Company which, according to information, is a dry mixture of 70 percent 2, 4-dichlorophenoxyacetic acid and 30 percent sodium bicarbonate. Upon dissolving in water the sodium salt of 2, 4-dichlorophenoxyacetic acid is formed. For this reason the substance will henceforth be referred to in this paper as 2, 4-D salt. Sometimes aqueous solutions of the 2, 4-D salt were mixed with varying amounts and concentrations of the onion extract.

A certified strain of the Red Kidney bean obtained from Ferry-Morse Seed Company was used as the experimental plant material for testing the herbicidal action of the various solutions containing 2, 4-D salt. The bean seedlings, approximately 8 cm. tall, were selected for size and uniformity of development. Approximately 0.05 ml. of solution was placed upon the upper surface of the blade of one of the pair of primary leaves at a point on the midrib approximately ½ cm. from the base of the blade (1). The solution was placed on the leaf by means of a Cenco dropper bulb micro pipette; this modification of the Mitchell and Hamner technique facilitated the treatment. The concentration of the 2, 4-D salt in the solutions was kept at 1,000 p.p.m. in all tests reported here. The plants were harvested 10 days after treatment, and the average fresh weight of growth above the primary leaves was recorded for each treatment. The plants were treated in groups so that statistical analysis could be applied.

In addition to onion, other plant materials were similarly extracted and separately combined with the 2, 4-D salt.

DISCUSSION OF RESULTS

The combination of the sodium salt of 2, 4-dichlorophenoxyacetic acid and onion extracts caused increased inhibiting effect in all cases where proper concentration of the onion material was used. It has

Fig. 1. The effect of pH changes in solutions containing 1,000 p.p.m. of the 2, 4-D salt upon the inhibition of shoot growth on bean plants. Plants from left to right: (1) treated with 2, 4-D salt solution buffered at pH 3; (2) treated with 2, 4-D salt solution buffered at pH 6; (3) treated with 2, 4-D salt solution buffered at pH 9. Picture taken 8 days after treatment.

been observed that the activating effect of the onion extract is optimal if it is prepared by diluting 1 part of onion with 20 to 30 parts by weight of distilled water. Lower and higher dilutions are less effective. If a dilution of approximately 1:50 is exceeded the activating effect is lost. The effect also depends on the pH at which the extract is held. In alkaline solution the onion extract is nearly ineffective while it increases the action of the 2, 4-D salt over a wide range from neutral to acid.

The authors have also been able to show that acidification of solutions of 2, 4-D salt in distilled water greatly increased their activity (Fig. 1). There seems to be a specific factor involved, however. The authors succeeded in increasing the action of the 2, 4-D salt by the addition of certain concentrations of citric and l-malic acid to such an extent that it was equivalent to that of the ester, applied in the form of the commercial preparation Weedone. Other organic acids, having a similar pH, did not produce the same effect. It

should be remembered that in an earlier publication Dolk and Thimann (2) had reported that auxin solutions caused greater curvatures in the *Avena* test when applied at a lower pH.

The pH of the plant extracts used was therefore determined in each case. It has been found that no significant change in pH takes place on the addition of onion extracts to 2, 4-D salt solutions or on the introduction of the 2, 4-D salt into onion extracts. The pH of onion extracts prepared with distilled water, which normally ranges between 5.2 and 5.7, rose to a value slightly below or above 6.0 after the salt was dissolved in them.

It was noted that the use of substances with adsorptive properties increased the activity of the onion extract if they were thoroughly mixed with the liquid and filtered off. The following substances were tested: (1) Celite No. 503, an asbestos fiber preparation, widely used as filtering material. (2) Norit A, an activated charcoal. (3) Pulverized Permalite, a complex silicate. All materials apparently removed substances which interfered with the activating agent. The wide variety of the nature of the substances used for adsorption seems to indicate that other adsorbents might give the same or even better results. Boiling for 5 minutes did not affect the ability of the onion extract to enhance the action of the 2, 4-D salt.

In Table 1 the effect of added onion extract is shown. It is evident from the figures that the preparation of the extract is a factor of considerable importance. Compared with the activation of the 2, 4-D salt by the concentrated onion extract the effect of the dilute extract is almost twice as great and the concentrated extract after treatment

TABLE 1—*Fresh weight in grams of bean shoots determined 10 days after treatment with various preparations of 2,4-D salt. Treatment was made by placing one drop (approx. 0.05 ml.) of solution on the base of one of the blades of the primary leaves. The shoots taken include all growth above the primary leaves.*

Treatment	Average weight of shoots per plant	Average weight of shoots on percent basis (Aq. 2, 4–D = 100)
Control (untreated)	2.16	180
2, 4–D salt at 1000 p.p.m.	1.20	100
2, 4–D salt at 1000 p.p.m. in concentrated onion extract	0.55	46
2, 4–D salt at 1000 p.p.m. in dilute onion extract	0.29	24
2, 4–D salt at 1000 p.p.m. in concentrated onion extract (Celite treated)	0.16	13
Concentrated onion extract only	2.17	180
Dilute onion extract only	2.10	175

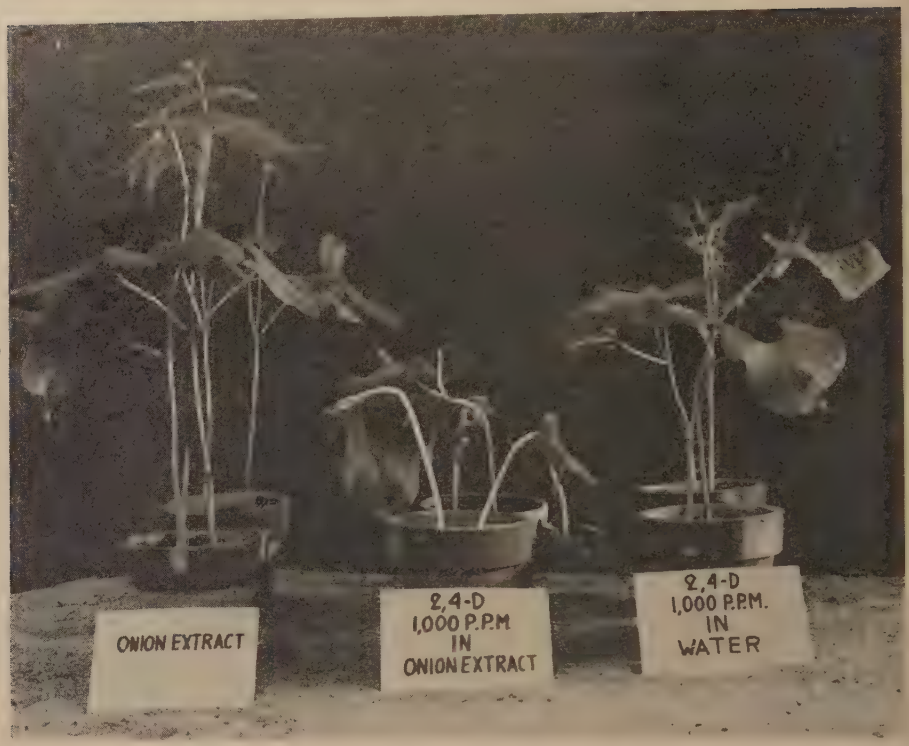

Fig. 2. The effect of 2, 4-D salt in onion extract as compared with that of 2, 4-D salt in distilled water on the growth of bean plants 10 days after treatment of one of the primary leaves with 0.05 ml. of solution. The application of onion extract alone shows no effect.

with Celite more than three times as great if shoot growth is taken as indicator. The onion extract when used without the 2, 4-D salt had no inhibitory effect on growth. This is also illustrated in Fig. 2. The stunting action of the 2, 4-D salt in aqueous solution and the formative effects exhibited by the leaves of the shoots after this treatment are in sharp contrast to the unhampered growth of the plants treated with onion extract alone. The combination of these two treatments, however, indicates a definite synergistic effect, expressed in twisting and swelling of stems and petioles and nearly complete termination of shoot growth. Fig. 3 gives a top view of plants subjected to a 2, 4-D salt treatment and the combined treatments. Here the mentioned differences between the two actions are more clearly brought out. The formative effect on the leaves of the shoots of the 2, 4-D salt treated plants and the arrested growth as the result of the combination treatment are distinctly noticeable. The appearance of

the plants treated with the combination of 2, 4-D salt and onion extract is not an unfamiliar sight. It resembles that of plants treated with higher doses of the salt or with the acid or its esters. These latter substances are not water-soluble, and if their effect could be matched by the much less expensive salt it would mean a considerable advantage for the purpose of weed control.

Several other plant extracts were used in combination with the 2, 4-D salt in order to determine whether similar effects could be obtained. Garlic, which is botanically and chemically closely related to the onion, was tested but the synergistic effect of its extract is much less pronounced than that of onion. Other plant extracts showed slight to intermediate effect. In one case (red beet) a rather significant inactivation of the 2, 4-D salt was noted. Growth of shoots was here markedly increased. These studies are being followed up. Table 2 shows the lack of action of tomato extract while it again gives evidence of the powerful effect of onion extract.

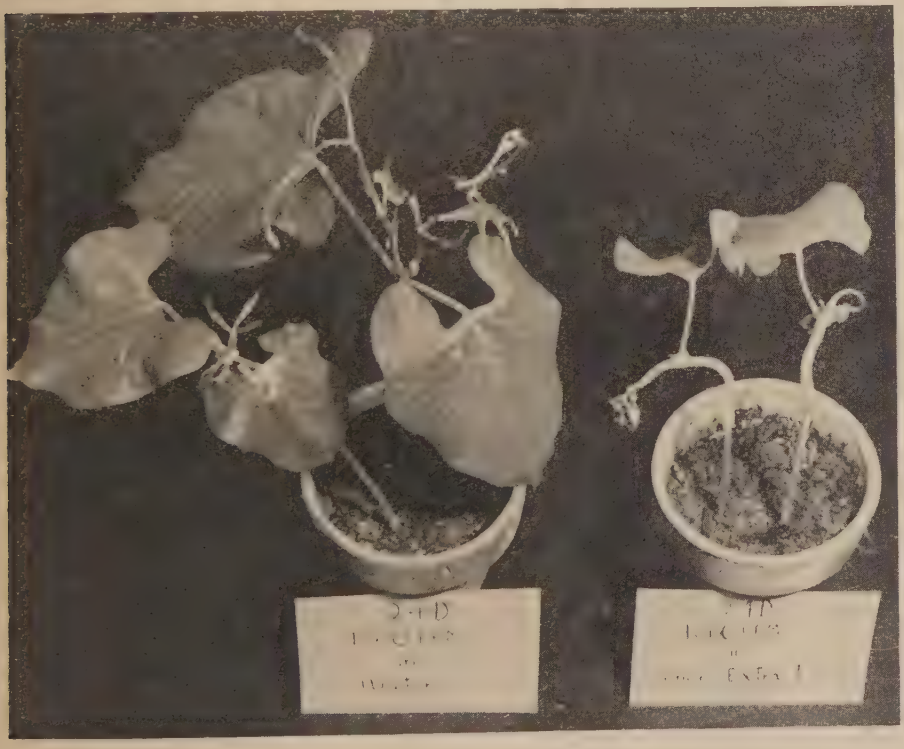

Fig. 3. A top view of bean plants after treatment of one of the primary leaves with 2, 4-D salt. Left: 2, 4-D salt in water. Right: 2, 4-D salt in onion extract. Picture taken 14 days after treatment.

TABLE 2—*Fresh weight in grams of bean shoots taken 10 days after treatment of one of the primary leaves with approximately 0.05 ml. of solution. The solutions of 2,4-D salt at 1000 p.p.m. were prepared with distilled water of onion extract or tomato leaf extract.*

Treatment	Average weight of shoots per plant	Average weight of shoots on percent basis (Aq. 2, 4–D = 100)
Control (untreated)	1.15	133
2, 4–D salt in water	0.86	100
2, 4–D salt in onion extract	0.48	56
2, 4–D salt in tomato leaf extract	0.80	93

SUMMARY

The modification of the physiological action of the sodium salt of 2, 4-dichlorophenoxyacetic acid by its combination with plant extracts is reported. In the experiments conducted herbicidal doses of 2, 4-D salt were employed. The extracts chiefly investigated were prepared from Michigan Sweet Spanish onions. Significant increases in the herbicidal action of the 2, 4-D salt were recorded.

Other plant extracts in their combination with the 2, 4-D salt were examined. The studies are being continued.

It was confirmed that acidification of the 2, 4-D preparations increases the effect of the treatment. It was also established that in alkaline solution the herbicidal effect of the 2, 4-D salt partly disappears. Further work is in progress.

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2. Dolk, H. E. and Thimann, K. V. I, Proc. Nat. Acad. Sc. 1932, *18*, 30

BULLETIN REVIEWS

Circular Bulletin 199

Soil Management Practices in the Orchard

Merrill, T. A.

An explanation of the place of cultivation, contour planting, terracing, sod cover, mulching, cover cropping and fertilization in the management of Michigan orchards. (30 pp., 1 table, 12 figs.)

Circular Bulletin 200

Fruit Purees

Paul, P.

This bulletin reports on a series of experiments relating to the preservation of peaches, plums, grapes, cherries, tomatoes, rhubarb and berries in the form of frozen purees. Recipes are given for their use in cookery. (19 pp., 1 table, 8 figs.)

Circular Bulletin 204

Soybeans and Soy Products in Quantity Cookery

Childs, M. M., Additon, E. G., and Ehlers, M. S.

An exposition of the place of the soybean and its products for human use. Uses of soybean flour, grits, sprouts, butter and milk are discussed. A large number of tested recipes are given. (56 pp., 3 figs.)

Special Bulletin 340

Weather Factors Influencing Honey Production

Jorgensen, C., and Markham, F.

An appraisal of the influence of the following factors on bee activity as measured by honey production: precipitation at different

periods of the year, temperature, wind, sunshine, atmospheric humidity, barometric pressure. In this study it was found that in Michigan June and July was the most important period for honey gathering. Maximum daily temperatures between 80 and 90 F. with humidity ranging from 40 to 70 percent, much sunshine and an average or below average rainfall during that period were conditions found most favorable for honey production. (22 pp., 6 tables, 5 figs.)

TECHNICAL BULLETIN 203

The Effect of Time of Application and Levels of Nitrogen, Phosphorus and Potash on the Growth of Sugar Beets with a Detailed Statistical Procedure of Confounding in a 3x3x3 Design

Davis, J. F., Baten, W. D., and Cook, R. L.

This bulletin presents a complete statistical analysis of results obtained from a sugar beet experiment laid out in a 3x3x3 design, replicated four times, where confounding of the second order interaction was employed. The treatments used comprise all combinations of three times of side-dressing, three levels of nitrogen and three levels of phosphorus and potash. The three times of side-dressing were: all the fertilizer for any treatment applied in one application; the same total amount of fertilizer applied in two applications; and the same total amount of fertilizer applied in three applications. A basic application of 300 pounds per acre of 2-16-8 was made at the time of planting. The levels of nitrogen were 50, 100, and 200 pounds of 20-0-0, and the levels of phosphorus and potash were none, 200 pounds of 0-20-0 and 40 pounds of 0-0-50 and 400 pounds of 0-20-0, and 80 pounds of 0-0-50.

Included in the bulletin is a statistical analysis for a simple 3x3 design wherein is described a method of dividing the interaction sum of squares into two sums of squares. It is explained how the fundamentals of confounding are based upon this method. Analysis of simple 3x3x3 designs are next presented so the reader is able to understand how experiments employing confounding are set up, laid out in the field and analyzed. After considerable details are given pertaining to the fundamentals of confounding, the results of the sugar beet experiment are then completely analyzed. Methods are exhibited for securing main and interaction effects sums of squares,

together with methods for disentangling second order interaction effects from blocks. Ways are shown for adjusting treatment averages because of confounding, together with variances for the same. Response curves reveal the effects of times of applications of the fertilizers, levels of nitrogen, and levels of phosphorus and potash.
The following results were secured:

1. Applying all of the fertilizer used for side-dressing purposes approximately 7 weeks after planting the sugar beets proved under the conditions of this experiment to be superior to applying the same quantity of fertilizer in either two or three split applications.

2. No significant differences in stand, yield of roots, or yield of tops resulted from either the nitrogen or phosphorus or potash applications used in this experiment. However, the application of nitrogen raised the percent of nitrogen in the tops.

(40 pp., 30 tables, 8 figs.)

JOURNAL ARTICLE ABSTRACTS

Types of Pods of Asclepias syriaca Found in Michigan

SPARROW, F. K.

Jour. Agr. Res. 73 (3): 65-80. 1946. [*Journal Article 770 (n. s.) from the Michigan Agricultural Experiment Station*]

As part of a wartime investigation of fiber substitutes for kapok, certain botanical features of the Common Milkweed centering around the seed floss were studied. In the present paper 49 distinct pod (fruit) types from localities in 12 different counties in the lower peninsula of Michigan were carefully described, figured and given locality designations. These were selected as illustrating certain striking structural features of the pod.

An arbitrary, purely utilitarian classification of pod types was erected to serve as a framework for an orderly description of pods selected from a large population and for a study of possible differences in floss characteristics. Features utilized were the general shape of the pod, ratio of length to diameter, ornamentation, and color and pubescence.

Since in a limited area wide variety of very distinctive pod types could be collected it seems certain that these are not mere environmental variations but, rather, genetic entities.

Correlated with differences in pod types there are also differences in floss characteristics. Selection of plants bearing pods with favorable floss qualities can be made the starting point for commercial clones which when interplanted with other mutually compatible, desirable, clones (the species is self-incompatible) will provide the basis for improved milkweed culture.

A Critical Study of the Summation-of-Difference-in-Rank Method of Determining Proficiency in Judging Dairy Products

BATEN, W. D., AND TROUT, G. M.

Biometrics Bull. 2 (4): 67-69. 1946. [*Journal Article 802 (n. s.) from the Michigan Agricultural Experiment Station*]

The summation of differences in ranks between the official and student placements of samples of butter, cheese, milk or ice cream

has been used in part to determine the rating of student judges in the collegiate student national dairy products judging contests. This article presents the frequency distribution of all possible scores which a student can make in the contest, together with its arithmetic average and standard deviation. This distribution reveals that most of the scores are equal to or larger than 12, that there are many ways of securing a small score. More than 60 percent of the scores are equal to or greater than 16. The mean and standard deviation point out that a student would have to make a score of 8 or less to indicate that he had used ability in judging instead of guessing. All possible rank correlation coefficients between the official assortings and the various assortings were calculated and plotted as a histogram. Most of these correlation coefficients were zero or very near zero, showing that a large majority of the possible ranks are not related to the official ranks. These values also indicate that guessing could have been used by the students. This paper shows the fallacy of the rank method of scoring.

Composition of Fresh and Storage Eggs from Hens Fed Cottonseed and Non-Cottonseed Rations. 1. General Observations

SCHAIBLE, P. J., AND BANDEMER, S. L.

Poultry Science. 25 (5): 440-445. 1946. [*Journal Article 807 (n. s.) from the Michigan Agricultural Experiment Station*]

Whites of eggs developed an orange to pink color after long periods of storage. If cottonseed products were in the hen's ration, this occurred usually after four months and the yolks became olive or salmon-colored as well. Individual hens reacted differently to cottonseed rations, some producing eggs which discolored in the short storage period, while others did not.

Discoloration resulted from the diffusion of some ingredient of yolk into white and *vice versa*, since separated yolks and whites or eggs frozen in the shell did not discolor.

Both yolks and whites of discolored eggs drifted toward pH 8.4 during cold storage. In an early stage, the yolk material just under the vitelline membrane had a higher pH than did the center. Yolks frequently became enlarged and separated into several zones during storage. This was caused by diffusion of white into yolk with the resulting dilution and breaking of the yolk emulsion.

The Control of Microorganisms in Food Storage Rooms

MALLMANN, W. L., AND CHURCHILL, E. S.

Refrigerating Engineering. 51 (6): 523-528. 1946. [*Journal Article 816 (n. s.) from the Michigan Agricultural Experiment Station*]

Ultraviolet rays reduced bacteria on surfaces that were irradiated, followed by a gradual increase after prolonged irradiation. In closed rooms, surfaces shielded from direct irradiation showed a reduction in surface populations, comparable with that from exposure to ozone atmospheres.

In laboratory tests carbon dioxide in a concentration of 2.5 percent checked rate of growth of bacteria on surfaces. Five- and 10-percent concentrations caused 45- to 90-percent reductions in populations, depending on type of bacteria.

Glycols when vaporized into the air caused reductions of 40 to 90 percent, but had no lethal effect on spores.

All these agents may be classed as possessing marginal sanitizing value with special uses in refrigerated and food handling rooms.

Hypochlorites and quartenary ammonium chlorides were also found useful for surface disinfection.

Since surface sanitizers have only limited action on bacterial spores, gross contamination must be dealt with by thorough washing and flushing of surfaces.

Tyrothricin Ointment in the Treatment of Udder and Teat Injuries

BRYAN, C. S.

North Amer. Vet. 27 (10): 628-632. 1946. [*Journal Article 818 (n. s.) from the Michigan Agricultural Experiment Station*]

The application of a water-washable based tyrothricin ointment to 111 cases of teat and udder injuries resulted in more rapid healing of these wounds and fewer local and udder infections than when the wounds were merely cleaned with soap and water on 48 control cases.

Studies on the Effect of Copper Sulfate Applied to Organic Soil on the Yield and Quality of Several Crops

HARMER, P. M.

Soil Sci. Soc. Amer. Proc. 10: 284-294. 1946. [*Journal Article 822 (n. s.) from the Michigan Agricultural Experiment Station*]

The response to copper sulfate applied to organic soil shown by a given crop is likely to depend on the amount required by that crop, on the reaction of the plowed layer and of the underlying drained layers, on the drainage conditions and on the seasonal climate. The more acid the organic soil, the greater will be the relative response to copper and the greater the number of crops likely to respond to it. Most crops are likely to be benefited by copper if the natural pH is 6.0 or less, the more responsive if the pH is 6.5, and the most responsive if the soil is alkaline. The amount of deficiency shown by a responsive crop on acid soil is likely to vary from one part of a field to another, probably due to variation in natural available copper content of the soil. A shallow-rooted crop may show more need for copper than a deep-rooted crop if the drained underlying soil is less acid than the plowed layer. Amount of response is likely to be greater in a hot, dry summer than in a cool, wet one. Crops may be grouped according to their response to copper on Michigan organic soil as follows: (a) None to slight—beans, celery, corn, peppermint, peas, rape, rutabagas, spearmint; (b) slight to medium—cabbage, mangels, parsnips, potatoes, sugar beets, Swiss chard, tomatoes, turnips; (c) medium to large—barley, carrots, cauliflower, Hungarian millet, oats, radishes, sunflowers, table beets; (d) large to very large—dill, lettuce, onions, spinach, Sudan grass, wheat.

Penicillin Mastics in the Treatment of Chronic Streptococcic Mastitis

BRYAN, C. S.

Vet. Med. 41 (12): 429-432. 1946. [*Journal Article 835 (n. s.) from the Michigan Agricultural Experiment Station*]

Mastics, a new penicillin medication form, were used to treat 82 cows with chronic streptococcic mastitis in 9 herds. None of these cows had any marked indurations of their udders. Seventy-six, or 92.6 percent of the cows treated, became free from the streptococcic

udder infection while 6 cows or 7.4 percent remained infected despite repeated treatment.

Of the 76 that recovered following treatment 4, or 3.2 percent, required one treatment but were reexposed and became reinfected; 37 additional cows or 48.8 percent needed but one treatment and have remained free of infection to date—8 months—while the remaining 35 cows or 46 percent received repeated treatment to effect recovery. Three of the reinfected cows recovered following one mastic treatment while the fourth required two mastic treatments on successive days 10 days after one mastic had been applied but failed to effect recovery.

The number of treatments necessary to effect recovery in the 36 cows requiring repeated treatments was variable. Of 14 given one mastic per quarter on two successive days 11 became free of udder infection while 3 remained infected. Two of these cows were then given one mastic per quarter on each of the three successive days and the third was given one mastic per quarter per day for four days to effect recovery. Of three of the infected cows started on treatment by giving one mastic per quarter on three successive days prior to test, 2 recovered while the 3rd was given a second series of three treatments over three days to effect recovery. The remaining 18 became free of the streptococcic mastitis after repeated treatment; the number of treatments necessary was variable.

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